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THE EXPERIMENTAL WATER FILTRATION PLANT AND THE FILTER PLANT IMPROVEMENT OF THE PEOPLE'S WATER CO., OAKLAND, CAL.

By W. W. DE BERARD,* Assoc. M. Am. Soc. C. E., and LANGDON PEARSE,* Jun. Am. Soc. C. E.

For many years, the residents of the various cities on the east side of the San Francisco Bay have derived their water supply from private companies, and prior to 1907 chiefly from the Contra Costa Water Co. In 1907, all the properties were consolidated under the name of the People's Water Co. To the new company was presented the problem of caring for the remarkable growth in population from about 200,000 to 300,000, following the San Francisco disaster of April 18, 1906. [See article by Mr. P. E. Harroun, Eng. News, May 7, 1908, on the new works and extensions.—Ed.]

Mr. Arthur L. Adams, M. Am. Soc. C. E., was engaged by the People's Water Co. as Chief Engineer to organize a Department of Greater Water Supply to investigate, plan and construct such works as are necessary to provide an adequate water supply for the present and future.

In a few words, the scheme, as finally developed, comprises the impounding of large volumes of water during the two or three rainy months, from streams which are practically dry the rest of the year. It is proposed to build three main storage reservoirs and several diverting dams, to be connected by tunnels and pipe lines with three filter plants, from which the water will be delivered to the distribution system.

The character of the drainage area is such that a great deal of turbidity is carried by the streams in the rainy season. This is due to the peculiar formation of the hills, which are composed chiefly of adobe, standing at the angle of repose, and eroding easily under heavy downpours. The result is that the water reaching the reservoirs always carries a deal of fine clay in suspension, which settles very slowly, so that at the end of nine months there is still a marked turbidity. The storage of such surface waters also promotes the growth of algae, which is peculiarly favored by the even climate of the region around the Bay. The drainage areas are sparsely settled, but there is always danger of chance pollution.

THE EXPERIMENTAL FILTRATION PLANT.

In order successfully to treat this type of water, filtration of some kind was decided upon. No scientific studies of Pacific Coast waters had ever been made. Therefore, owing to the magnitude of the work proposed, an experimental filtration station was built in order to secure data on the conditions to be expected during the cycle of a year, as well as to settle certain details of design. It was recognized at the start that mechanical filtration was probably adequate, but it was thought best to operate two slow sand filters to see how successfully these could handle the water under the constant temperature conditions which exist in this part of California. The general intent has been to study the details of certain phases of rapid filtration, such as the wash and preliminary treatment, rather than to test the superiority of slow sand over rapid filters.

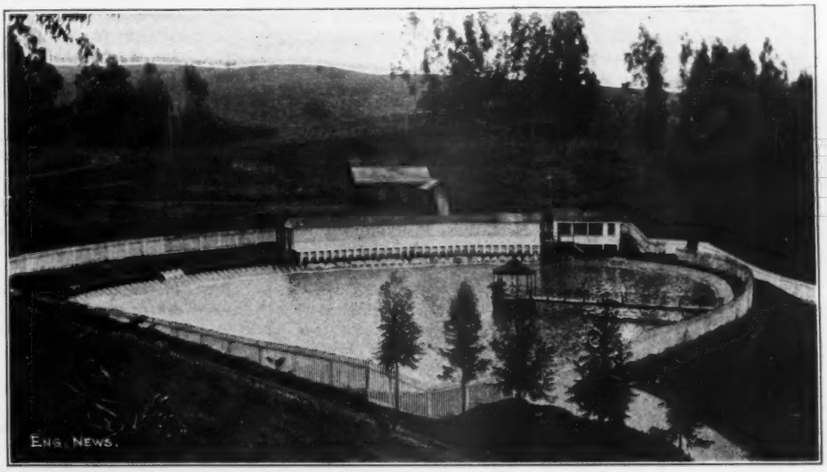


FIG. 1. SETTLING BASIN, SCREEN HOUSE AND NEW FLUME AT OLD WATER PURIFICATION PLANT, OAKLAND, CAL.

The most available site for the testing station was on the company's property at San Leandro, about half a mile from the dam forming the present main reservoir, Lake Chabot. This, with a capacity of 5,000,000,000 gals., furnishes a supply of water collected from a drainage area similar to the ones proposed. The location was so chosen that the filtrate from the testing station discharged directly into an old distributing reservoir on the Oakland pipe system.

While the testing station was being built in May and June, 1907, the operating department of the People's Water Co. was equipping a sanitary laboratory in the Oakland office, under the direction of Prof. Charles Gilman Hyde, with F. M. Eaton as chemist and B. G. Philbrick as bacteriologist.

The general layout of the testing station is new (see Fig. 2), but many of the small details are similar to those which have been used elsewhere. The equipment consists of two slow-sand filters (not shown in Fig. 2) and three rapid-filter units, fed from common mixing and coagulating tanks. Owing to the heavy continued rains which occur in California during the rainy season, all the operating machinery and devices of the rapid-filter equipment were placed under cover.

The raw water is drawn from a 24-in. main by a 4-in. pipe passing directly into the building on the upper floor and discharging into a large orifice box, which measures the entire flow. The water in the orifice box is kept at any desired level by adjusting a float, which is connected to a 3-in. Mason regulating valve by a lever. The operation of the lever is restrained by a rubber spring to prevent water hammer. The orifice plate is made of ⅛-in. brass and contains nine ¾-in. standard orifices. The head may be run to a maximum of 25 ins., passing a gross discharge of about 125,000 gals. per day.

On the upper floor of the building there are also three circular coagulant tubs, built of 1¼-in. redwood, 4 ft. in diameter. Two are 3 ft. deep and the third 4 ft. deep. These feed two small orifice boxes, equipped with orifice plates ⅛-in. thick, containing six 3/32-in. standard orifices. Either box or both boxes can be run at the same time, on the same or different tubs, so that lime and iron can be applied if desired. Under each orifice plate is a small funnel piped into the large funnel under the main raw-water orifice box mentioned above. From this point, the coagulant and water pass through a 4-in. pipe directly to the far end of the mixing tank (outdoors; Fig. 3).

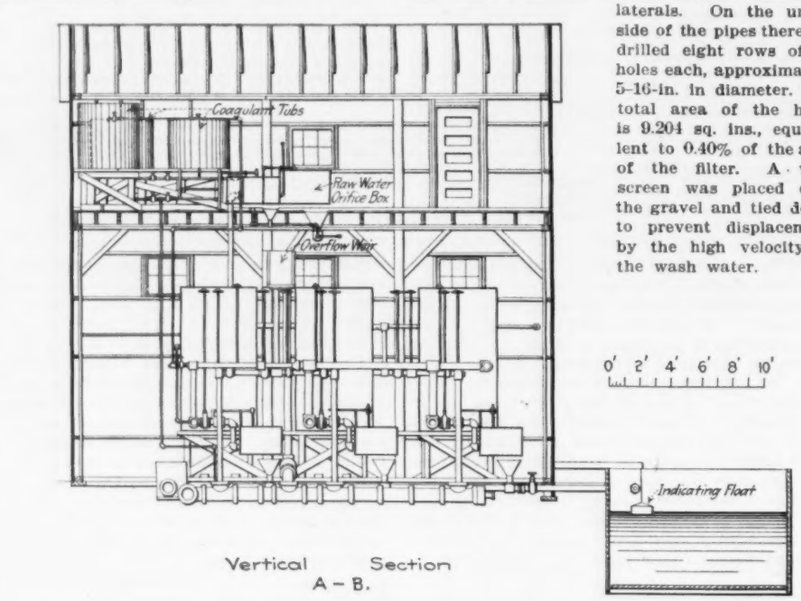
The mixing tank was designed to have sufficient capacity to supply three filters, running at the rate of 100,000,000 gals. per acre per day, with about one hour storage. This gave a capacity of 5,000 gals. The tank is rectangular, 10 × 14 ft. in plan by 5 ft. deep, baffled so that the available run is about 53 ft., giving an average velocity of flow of 0.9-ft. per min. at the rate mentioned. The water on entering drops down behind a baffle to a depth of 9 ins. above the floor of the tank, then passes forward and upward, and is taken off at the surface over a skimming weir. The flow may then be diverted direct to the rapid filters or be turned into a second tank (Fig. 3), circular in plan, 15½ ft. in diameter and 5½ ft. deep, holding 7,000 gals. This tank is provided with an inner circular baffle and a skimming weir at the exit. The additional storage provided for by this tank is 1.3 hours for three filters running at the rate of 100 m. g. d. per acre. The maximum period of storage obtainable is 6.9 hours when feeding one

*People's Water Co., 1014 Broadway, Oakland, Cal

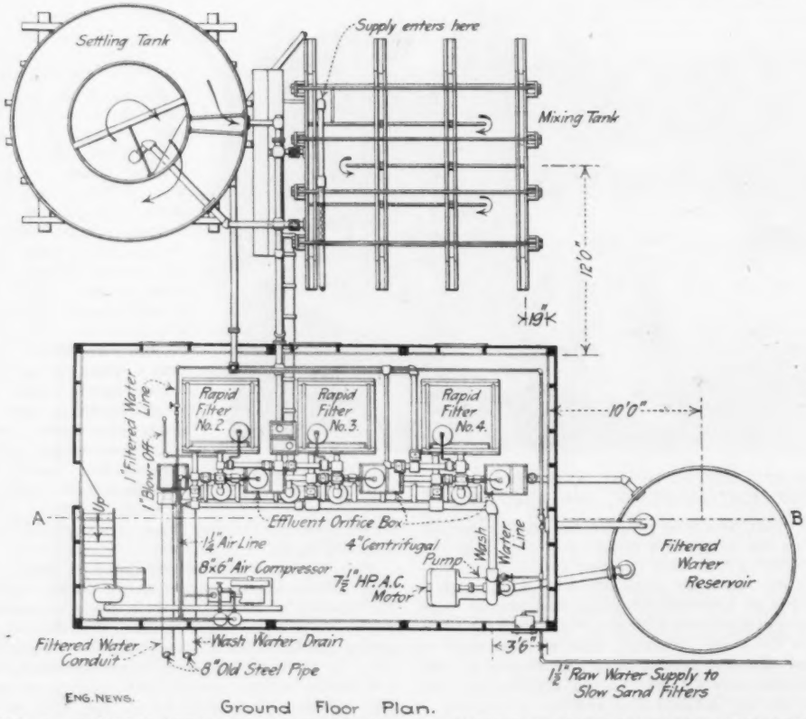
filter at the rate of 100 m. g. d. per acre per day. The operation of the plant is planned so that more than enough water is coagulated and settled to care for all the filters in operation. This slight excess is wasted. In this way the coagulant experiment is entirely separate. In addition, all the filters work on the same kind of water. A direct comparison of the filters is thus possible. To give different periods of storage above 2.3 hours one or more filters are shut down.

header with eight 1¼-in. lateral pipes spaced 6 ins. c. to c. On the under side of the pipes are drilled 7/32 in. diameter holes, 3 ins. c. to c. This gives eight rows of 16 holes each, making a total of 128 holes, with a total area of 4.81 sq. ins., equivalent to about 0.21% of the area of the filter.

A second filter is designed for a high-rate wash, with water only, using a pipe system similar to the first, but with a 4-in. header and 2-in. laterals. On the under side of the pipes there are drilled eight rows of 15 holes each, approximately 5-16-in. in diameter. The total area of the holes is 9.204 sq. ins., equivalent to 0.40% of the area of the filter. A wire screen was placed over the gravel and tied down to prevent displacement by the high velocity of the wash water.



Vertical Section A – B.



Ground Floor Plan.

FIG. 2. GENERAL ARRANGEMENT EXPERIMENTAL WATER FILTRATION PLANT, PEOPLE'S WATER CO., OAKLAND, CAL.

The coagulated and settled water passes back into the house through a 4-in. line, backing up into a weir box which provides an overflow for the excess over the requirements of the filters. The inflow to each filter is governed by a butterfly valve, connected by a lever to a float.

The rapid filters are made up in redwood tanks 3 ins. thick, 4 ft. sq. inside and 9 ft. deep. One filter is designed to use air and water alternately through a single-pipe system similar to that installed at Harrisburg, Pa. This underdrain system consists of a 3-in. galvanized-iron pipe

The third filter has an underdrain system patterned after that at Cincinnati, O., except that it is built of wood instead of concrete, and the wire screens over the gravel are omitted (Fig. 4). There are six plates, each containing 58 3/16-in. holes. The total area of the 348 holes in the plates is 9.6 sq. ins., equivalent to 0.42% of the area of the filter. During the experiments, this filter was rebuilt, using plates each containing the same number of holes as before, but ⅛ in. in diameter, equivalent to 0.18% of the area of the filter.

A number of different sands have been used in these filters with an effective size varying from 0.33 to 0.5 mm., and uniformity coefficients varying from 1.2 to 1.4.

In addition to the air wash and the high-rate water wash, experiments are being carried on with an auxiliary water wash of the surface sand. A grid of small perforated pipes is placed above the sand layer when it is at rest. During washing, the sand rises over the grid and is agitated by the jets issuing from the perforations. The amount of water used by the grid is measured by a 2-in. meter. Various combinations of water through the underdrains and grid are being tried, together with different positions of the grid with respect to the surface of the sand.

Suitable gage glasses are provided to show the loss of head. Special gages have been installed in one filter to determine the loss of head at various depths below the sand surface. The gutters are built up of redwood in sections for easy adjustment. All the valves for operating the filters can be controlled from the filter deck, a half floor about 3 ft. below the top of the filters.

From the strainer system the water passes through an orifice box (Fig. 5) which controls the rate of filtration automatically by a float connected to a 3-in. Mason regulating valve by a lever. Brass orifice plates are used, ⅛ in. thick, containing five ¾-in. standard orifices. Each orifice box discharges into a galvanized-iron funnel, 18 ins. in diameter, connected to a common filtered-water pipe, 3 ins. in diameter, which opens into a 5,000-gal. tank 12 ft. in diameter, 7½ ft. deep, of 1¾-in. redwood stock, sunk in the ground outside the station. This tank may be cut out by closing a gate. If this is done or the tank is full, the filtered water discharges automatically over the overflow weir into the distributing reservoir of the Oakland system. A wire carrying a cylindrical indicator is run over pulleys from a float in this tank to a gage reading directly in gallons located inside the building. From this tank the wash water is pumped by a 4-in. centrifugal pump. A 5-in. main allows an ample supply at a low loss of head, so that it is possible to wash two of the filters at as high a rate as 3½ ft. vertical rise per minute.

The air required for the filter agitation, and for stirring the chemical solutions, is provided by an air compressor specially designed to deliver 60 cu. ft. of air a minute at a pressure of 6 lbs. per sq. in.

In order that both the rapid and the slow-sand filters might be operated with the same raw-water supply, a 1½-in. pipe was run down from the station to the slow-sand tanks, 100 ft. away. This was connected up to the funnel under the orifice box of one of the rapid filters so that the filter could be used as a scrubber for preliminary treatment if desired.

The slow-sand filters were built in redwood tanks, 5 ft. in diameter and 8 ft. deep, 1¾-in. staves, with a 4-in. agricultural drain tile underdrain radiating from the center. This tile was put in with loose joints and surrounded by coarse gravel. Both filters are piped up to orifice boxes, which control the flow automatically by a float and lever actuating a 2-in. Mason regulating valve. A drain pipe is also provided with a special metal disk which can be lowered to the surface of the bed when it is desired to drain off the water above the sand.

For the operation of the testing station an organization has been formed of four recent university graduates, one being put in charge. The shifts are twelve hours each. The day man is on for two weeks, while the night men alternate every two days. The man in charge looks after the general operation, brings in the samples every morning and helps in keeping up the records.

The scheme for keeping the records is a loose-leaf system (Fig. 7) boiled down to as few sheets as possible, in order to avoid the copying of data. All the calculations are worked up and checked on the original field sheets on which the bacterial, chemical and biological data are also entered; all this clerical work is done by the attendants. Each filter and the mixing tank has its respective sheet. On the filter sheets all the data concerning any particular run are shown. The

totals, averages or results desired are then copied on to a final summary sheet.

The records of loss of head, various orifice-scale readings, and coagulant quantities are taken every hour. The turbidities are read on the rapid-filter samples taken 3, 6, 9, 15 and 60 minutes after starting a new run, and at intervals of four hours thereafter until the close of the run. The loss of head and the grains per gallon of coagulant applied are immediately plotted on cross-section paper.

FIG. 3. REAR VIEW OF EXPERIMENTAL WATER FILTRATION PLANT, OAKLAND, CAL., SHOWING SETTLING AND MIXING TANKS.

The bacterial samples are taken in bottles, especially designed for the work by Professor Hyde (Fig. 6). A card is made out for each sample and fastened with a rubber band around the copper canister enclosing the bottle. A record is also kept on the filter sheet so that when the count has been made, it can be readily entered on the original sheet.

A diagrammatic scheme has been worked up to show the various factors entering into the runs of the filters and the results obtained. There has been plotted the hourly coagulant applied, the average coagulant for each run, the period of storage, the turbidity and bacteria per c.c. of the supply, coagulated water and filter effluent together with the average bacteria per c.c. of the separate runs. From these diagrams, comparative studies can readily be made without the labor of carrying in mind a detailed mass of figures.

CHANGES IN THE OLD WATER PURIFICATION PLANT.

Near the testing station are two batteries of Hyatt pressure filters, installed by one of the old companies in 1888 and 1890. These filters were built to furnish 4,000,000 gals. daily at the rate of 100 m. g. d. per acre. The rate was gradually increased until at the present time the filters are called upon to deliver from 10 to 14 m. g. d. At this rate, approximately 250 to 350 m. g. d. per acre, good work was impossible under the existing conditions. The coagulant was applied directly before the water entered the filters, at no definite rate. As a temporary measure, pending the construction of the new works, this serious defect has just been remedied at small expense by utilizing an abandoned reservoir as a coagulating and settling basin. With a capacity of about 1,500,000 gals., this gives a nominal length of storage from 2½ to 4½ hours, according to the rate of flow.

When used in the past the reservoir had been fed by an old "screen house," consisting of a flume 4 ft. 10 ins. × 4 ft. 9 ins. deep, 100 ft. long, covered with a walk and frame house. Just above the bottom of the flume were 30 openings 6 ins. sq., in front of which muslin screens about 24 ins. wide were placed to remove mechanically the algae growths. For the new improvement, the old holes were closed and an additional flume 2 × 2 ft., 100 ft. long, was built on, provided with 40 pipes 2½ ins. in diameter, 18 ft. long, screwed into the side at the bottom. Orifices were bored in the sides of the old flume, 2.78 ins. in diameter. These were found by experiment to discharge the same amount of water as each of the 2½-in. pipes. As all these openings are at the same elevation, the amount of water passing can readily be calculated, by observing a gage calibrated to show the million gallons per day discharged per orifice of pipe.

A storehouse to hold about two car loads of sulphate of alumina was built above the old screen house, at such an elevation that the barrels can be rolled directly over the top of the tanks in which the coagulant is mixed. These hold 5,000 gals. apiece and were provided with a brass grid through which air is blown to agitate the solution. A wooden box, holding five barrels, was built in the tank. The bottom and side of the box were perforated with 1-in. holes, covered with a copper screen. The water to make up the solution is pumped to the top of the box and sprayed over the crystallized aluminum sulphate. Both coagulant tanks were connected to a regulating box, equipped with a copper orifice plate containing four ½-in. and one ⅜-in. diameter standard orifices. Three calibrated brass lever-handle bibb cocks, ⅜, ½ and ¾-in. pipe size, were also provided. At present these cocks are used to set the rate, while a record is kept of the drop in the solution tank by reading a gage glass graduated to read in pounds of water. As a solution of known percentage is made up, the readings made allow quick figuring of the amount of coagulant added per gallon of water treated.

FIG. 4. EXPERIMENTAL UNDERDRAIN SYSTEM FOR WATER FILTER, OAKLAND, CAL.
(Gravel between the upper blocks.)

The following approximate formula was worked out for the filter attendants to use:

Q = quantity in million gallons daily.
G = grains per gallon.
P = percentage of solution.
L = pounds of solution used in time M in minutes.

$$G = \frac{L \times P \times 7{,}000 \times 60 \times 24}{Q \quad M} = \frac{L\,P}{Q\,M}\ 1{,}008{,}000.$$

For use $\frac{L\,P}{Q\,M}$ 1,000,000 is accurate within 1%.

For the greater part of the time a 1% solution has been used, simplifying the formula still further.

Readings of the solution tank and the quantity of water being treated are made at intervals of approximately one hour. Calculations of grains per gallon applied are immediately made so that the attendant knows at all times what amount of coagulant he is adding.

From the screen house and flume the coagulated water passes across the basin to an old circular outlet tower. To skim off the surface water a weir was built around the tower by using a 3-in. redwood tank 15⅓ ft. in diameter, 9½ ft. high in front, cut down to 7½ ft. high on the rear third, the farthest from the screen house. As normally operated there are from 2½ to 3 ft. of water over the lower crest.

The introduction of these improvements cut down the number of washings of the Hyatt filters from 3 to 2 a day, and steadied the rate of filtration. Owing to the remarkable overload on the filters, sometimes as much as 14 m. g. d. on a plant installed for 4 m. g. d., a coarse sand, effective size 0.69 mm., uniform coefficient 1.64, has been used of late years. Working with such rates and coarse sand, it is impossible to remove all the turbidity. A turbidity removal of 60 to 90% is, however, secured, and 50% of the bacteria are also taken out.

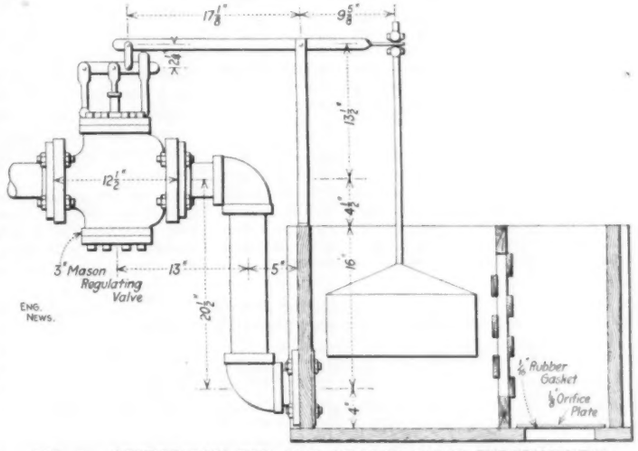


FIG. 5. ORIFICE BOX FOR ONE OF THE RAPID EXPERIMENTAL FILTERS, OAKLAND, CAL.

The construction work was done by day labor, the material being purchased in the open market, at a time when prices were high. All the buildings have Oregon pine frame, sheathed with redwood, well battened. The testing station building is covered with roofing paper, while the filter plant improvement has a shingled roof. The cost of the building above was 5 cts. per cu. ft., exclusive of salaries or superintendence. The total cost of the station was $5,000, and of the filter plant improvement $5,008. A view of the purification plant as it now appears is shown by Fig. 1.

The Department of Greater Water Supply is under the direction of Mr. Arthur L. Adams, Chief Engineer, and Mr. P. E. Harroun, Assistant Chief Engineer. Mr. W. W. DeBerard is in charge of the filtration investigations and the filter plant improvements, with Mr. Langdon Pearse as Assistant Engineer.

METHODS OF SURVEYING OYSTER BEDS ON MARYLAND SHORES.

Up to the last few years the oyster beds bordering the shores of the State of Maryland had not been subjected to regular or authorized planting, but were dredged as natural beds by the local residents. In 1906, however, the legislature passed a bill authorizing a Commission, whose duty it is to locate and map all the natural oyster beds lying under the waters of the State and to lease the barren and depleted bottoms to residents of the State, the revenues thereby derived to be applied to the building of good roads throughout the State. The first duty of the Commission was to make a hydrographic survey of the shores of Maryland, locating thereon all the oyster beds together with the stage of their fertility. To take charge of this work a Chief Engineer was appointed by the Commission to cooperate with the U. S. Coast and Geodetic Survey, which had been authorized by the Federal Congress to expend $15,000 on the surveys. While this hydrographic survey is not remarkable from an engineering viewpoint, some novel features may be of interest to engineers concerned in similar work. The following description of the survey is taken from a recent address on "The Maryland Oyster Survey and Prospects of Oyster Farming in Chesapeake Bay," delivered before the Engineers' Club of Baltimore by Mr. Swepson Earle, Chief Engineer of the Maryland Shellfish Commission:

The triangulation, erection of the shore stations, placing of monuments to mark the triangulation points, and publications of Coast and Geodetic Survey charts showing the oyster bars, is carried on under the direction of the representative of the Coast Survey.

The general triangulation and topography covering Chesapeake Bay and its tributaries was made about 1850 and within the past ten years many sections of the bay have been visited by new work. With this information available in the office of the Coast Survey, the State is furnished by that bureau with seasoned polyconic finished projections on scale of 1:10,000, from which boat sheets are made. The Coast Survey representative being furnished with the necessary descriptions of the triangulation stations, directs the erection of signals over as many of the old points as can be recovered. The hydrography, surveying of the oyster bars, depths, character of bottoms, tidal data, oyster bar examinations, currents and densities, and fixing the official boundaries and corners of the natural oyster bars, is carried on under the direction of the Maryland Commission, for which work the U. S. Bureau of Fisheries detailed the steam launch "Canvasback" with crew. The "Canvasback" has been used to survey all the river bars and the protected part of the Bay work. The Coast Survey furnishes the State with the necessary instruments used in making the survey. The methods used in making the survey of the oyster grounds in Maryland, with slight modifications, are the same as those used by the U. S. Coast and Geodetic Survey in making a hydrographic survey.

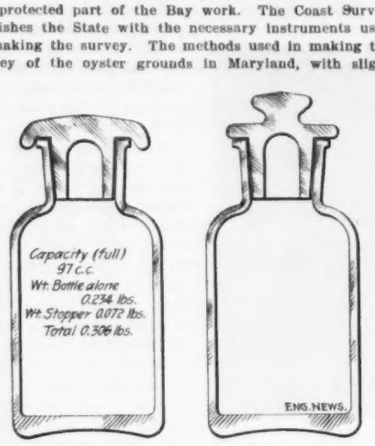


Fig. 6. Bottle for Water Samples for Bacterial Analysis, Oakland, Cal.

The observing boat carries seven men, two to locate with sextants, one recorder, one leadsman, one man to sound for oyster rock, one coxswain and one engineer, in addition to one buoy man in a rowboat towed by the launch. The locating observations are made from the rear of the launch by simultaneous sextant reading by two observers, using the familiar three-point plotting method.

During the progress of the launch over an oyster ground the leadsman, occupying a cage attached to the roof on the starboard side, forward, throws his lead at intervals of 15 to 20 secs., measuring the depth of water and testing the bottom at each cast. Having made a sounding the leadsman reports the depth of water, in fathoms and feet, and the character of the bottom in one of the following terms: "Hard," "soft," "sticky," "shells," "rocks" or "grassy." The record is dictated to the after part of the launch with a clock before him, notifies the leadsman at the end of each time interval, by the means of an electric bell, when it is time for soundings to be made, and in a sounding record book records the depths and bottom.

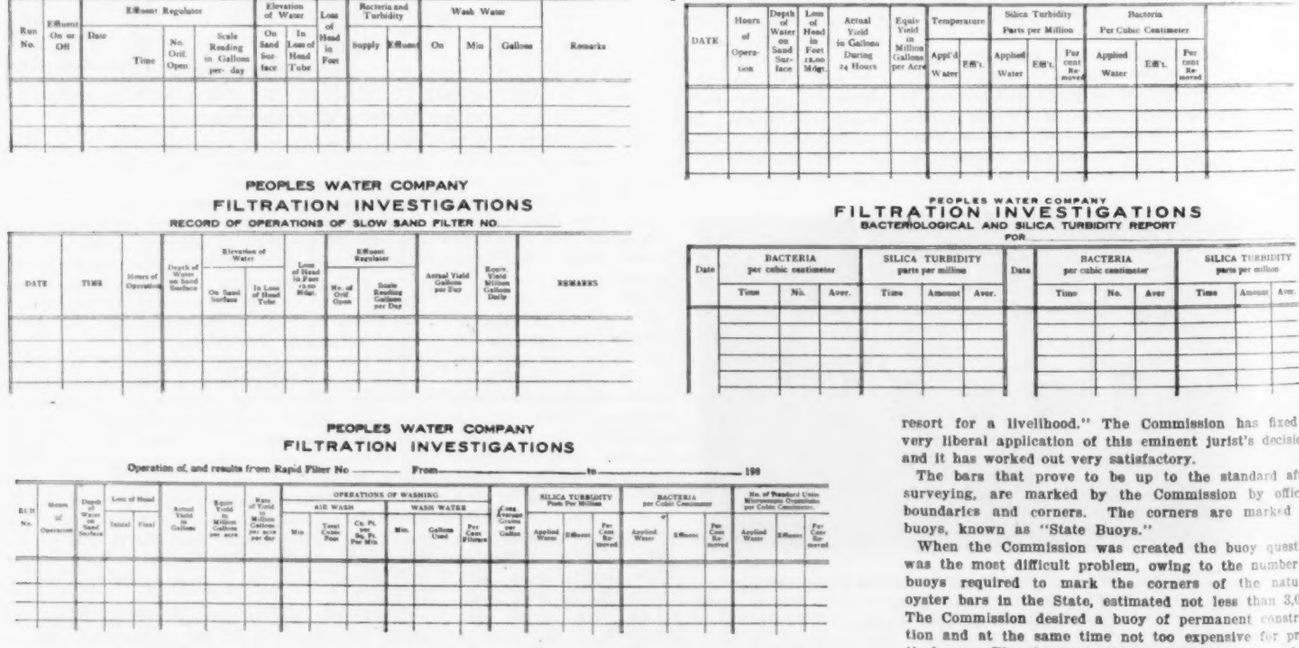
The local assistant,* operating a chain-wire apparatus from the forward port side of the launch, tests the oyster ground at the end of each time interval and reports to the recorder his findings in one of the following terms: "Barren," "very scattering," "scattering," "medium" or "dense." His report is given immediately following that of the leadsman and is recorded in the sounding record book with the initial letters of the terms used to describe the condition of the ground. The chain-wire apparatus consists in a drag made up of three short pieces of chain, fastened to the middle and ends of a wooden bar 2 ft. in length; to the joined ends of the three chains is attached a stout copper wire, to which, near the point where it passes to a reel on the launch, is joined a short slender wire which leads to a resonator fastened to the roof of the launch. When running a line of soundings the drag at the end of the stout wire is towed over the bottom, and from the vibrations or lack of vibrations on the wire the condition of the ground is inferred. The vibrations are detected by the hum of the resonanter or by holding the wire in the hand.

When the drag is passing over barren bottoms the chains tow smoothly and evenly and no vibrations are transmitted to the wire, but when shells and oysters are struck by the chains the wire is made to jerk and vibrate. If the vibrations are infrequent the inference is that shells or oysters are very scattering and when the vibrations become more frequent or constant a scattering, medium or dense growth of oysters is inferred. From the chain-wire readings in sounding launch it can be determined whether the boat is passing over barren bottom, shells, oysters or stones, but what standing the bar has relative to spat, shells, seed or marketable oysters, is proved by the examination launch "The Investigator." This fast gasoline launch is equipped with both hand and patent oyster tongs and is in charge of one of the assistant engineers, assisted by an expert tonger, coxswain and machinist. It follows the sounding launch and examines every spot marked by watch buoys thrown over at instructions from the drag tender by a watch buoy tender in a small boat in tow of the sounding launch. From these examinations it is easy to determine the standard of an oyster bar. The Commission has fixed a definition of "What is a natural oyster bar?" Judge Goldsborough gave a very wise decision of this important question some years ago, "Where oystermen resort for a livelihood." The Commission has fixed a very liberal application of this eminent jurist's decision, and it has worked out very satisfactory.

The bars that prove to be up to the standard after surveying, are marked by the Commission by official boundaries and corners. The corners are marked by buoys, known as "State Buoys."

When the Commission was created the buoy question was the most difficult problem, owing to the number of buoys required to mark the corners of the natural oyster bars in the State, estimated not less than 3,000. The Commission desired a buoy of permanent construction and at the same time not too expensive for practical use. The third and fourth-class spars as used by

*One of the sections of the Oyster Law provides for the appointment of a local oysterman in each county having natural oyster bars. The assistant accompanies the Engineer and roughly points out the location of the bars to be surveyed.


PEOPLES WATER COMPANY
FILTRATION INVESTIGATIONS
RECORD OF OPERATIONS OF RAPID FILTER NO.

Run No.	Effluent On or Off	Effluent Regulator: Date / Time	No. Orif. Open	Scale Reading in Gallons per day	Elevation of Water: On Sand Surface	In Loss of Head Tube	Loss of Head in Feet	Bacteria and Turbidity: Supply	Effluent	Wash Water: On	Min	Gallons	Remarks

PEOPLES WATER COMPANY
FILTRATION INVESTIGATIONS
RECORD OF OPERATIONS OF SLOW SAND FILTER NO.

DATE	TIME	Hours of Operation	Depth of Water on Sand Surface	Elevation of Water: On Sand Surface	In Loss of Head Tube	Loss of Head in Feet 12.00 Midgt.	Effluent Regulator: No. of Orif Open	Scale Reading Gallons per Day	Actual Yield Gallons per Day	Equiv Yield Million Gallons Daily	REMARKS

PEOPLES WATER COMPANY
FILTRATION INVESTIGATIONS
Operation of, and results from Rapid Filter No. ____ From ____ to ____ 190

Run No.	Hours of Operation	Depth of Water on Sand Surface	Loss of Head: Initial	Final	Actual Yield in Gallons	Equiv Yield in Million Gallons per acre	Rate of Yield in Million Gallons per acre per day	OPERATIONS OF WASHING: AIR WASH: Min	Total Cubic Feet	Cu. Ft. per Sq. Ft. Per Min.	WASH WATER: Min.	Gallons Used	Per Cent Filtered	Loss through Grains per Gallon	SILICA TURBIDITY Parts Per Million: Applied Water	Effluent	Per Cent Removed	BACTERIA per Cubic Centimeter: Applied Water	Effluent	Per Cent Removed	No. of Standard Units Micrococcus Cryptolitus per Cubic Centimeter: Applied Water	Effluent	Per Cent Removed

PEOPLES WATER COMPANY
FILTRATION INVESTIGATIONS
OPERATION OF AND RESULTS FROM Slow Sand Filter No. DURING

DATE	Hours of Operation	Depth of Water on Sand Surface	Loss of Head in Feet 12.00 Midgt.	Actual Yield in Gallons During 24 Hours	Equiv Yield in Million Gallons per Acre	Temperature: Appl'd Water	Effl't.	Silica Turbidity Parts per Million: Applied Water	Effl't.	Per cent Removed	Bacteria Per Cubic Centimeter: Applied Water	Effl't.	Per cent Removed

PEOPLES WATER COMPANY
FILTRATION INVESTIGATIONS
BACTERIOLOGICAL AND SILICA TURBIDITY REPORT
FOR

Date	BACTERIA per cubic centimeter: Time	No.	Aver.	SILICA TURBIDITY parts per million: Time	Amount	Aver.	Date	BACTERIA per cubic centimeter: Time	No.	Aver	SILICA TURBIDITY parts per million: Time	Amount	Aver.

FIG. 7. FIELD AND OFFICE OR FINAL SHEETS USED TO RECORD RESULTS OF TESTS OF EXPERIMENTAL WATER FILTERS, PEOPLE'S WATER CO., OAKLAND, CAL.

(The original sheets, all on the loose-leaf filing plan, are about 8½ ins. wide by 11 ins. high. One of the full set of six sheets is not reproduced. It is used as a log for the mixing tank, coagulant regulating orifice, and coagulating tanks.)

the U. S. Lighthouse Board, were found too expensive. On a visit to Connecticut (one of the leading oyster culture States in the Union) before putting the law into operation, and to see the working of the Oyster Culture Law in that State, the buoy question was carefully considered. It was found that the buoy used by the Connecticut Commission was only of a temporary character.*

The Commission's engineer then designed a specially constructed buoy for marking the official oyster bar corners. This buoy has met with the requirements of the Commission with regard to durability and cost. This type of buoy is used in water of all depths over 10 ft. In construction it consists of a seasoned cypress tree, barked and worked up in buoy shape, to the large or butt end of which is bolted or lag-screwed a U-shaped buoy iron. Concrete anchors weighing from 300 to 800 lbs., having a U-shaped ¾-in. staple embedded in the concrete when made, are used to maintain the floaters in place. A short section of ¾-in. or ½-in. chain (according to size of buoy and weight of anchor) is used to connect the buoy and stone. This chain is made fast to the staple and buoy iron by simple split links. The work of shaping up the cypress trees and making the concrete sinkers is carried on at the Commission's buoy stations at Crisfield and Annapolis at a considerable saving to the State, as the Commission's regular labor is used, and the cost of sand and gravel is practically nothing.

EXPORTS OF FOREST PRODUCTS from the United States, according to figures furnished by the Department of Agriculture, have generally decreased in amount considerably in spite of an increase in value. The quantity of sawed timber has increased less than 12% in four years while the value has increased 50%. The amount of rosin has increased but little while the value has more than doubled. There has been a decrease of about 10% in the number of white-oak staves exported in spite of an increase in value of 20%. The number of shingles has decreased regularly for four years. The exportation for 1907 was less than 50% that of 1903. The exception to the general tendency is in the case of redwood, the figures of 1907 being about five times those of 12 years ago and larger than of any previous year. Timbers and sawed lumber made up 50% of the total value of forest products exported last year; rosin, 10%; turpentine, 10%. The amount of wood exported as sawn or hewn lumber and timber in 1907 was about 7% of the total lumber cut in the United States.

*A pine sapling anchored to 150 lbs. burlap sand bag by section of rope attached about one-third the way up from its butt end.

A LIGHT THREE-HINGED CONCRETE ARCH BRIDGE IN ROCK CREEK PARK, WASHINGTON, D. C.

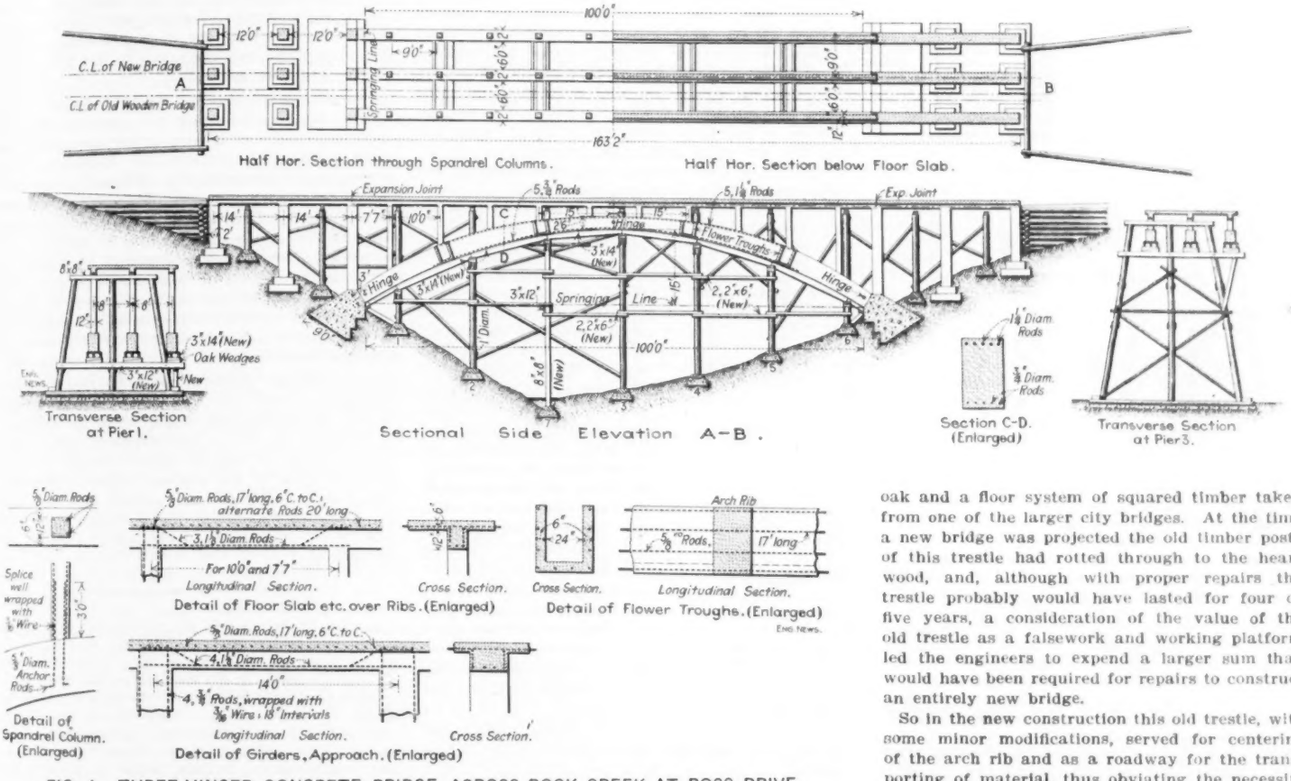
When Rock Creek Park, a national reservation just north of the city of Washington, was first opened, the necessities for traffic accommodations were such that nearly all gorge and creek crossings were made on timber trestles. These temporary bridges are now being gradually replaced by more permanent structures in the design of which every effort is being made to harmonize the artificial construction with the natural attractiveness of the surroundings so as to avoid, as far as possible, that very formal aspect so common in many of our city parks. These new bridges for the most part are of concrete, though not of similar design, each one conforming with the peculiar conditions of the site where it is placed; a rock-faced "Boulder Bridge" in a stony run, a pebble-dash concrete arch at a gravelly creek or a formally decorated tooled finish near the more thickly populated entrances. The last of these bridges to be built, the arch across Rock Creek on the line of Ross Drive, is in a thickly wooded gorge approached on each side by roads lining the valley. The vistas afforded from these roads required as light a structure as possible so as not to obstruct the view and the picturesque nature of the site suggested some treatment which would not obtrude but would blend well with the landscape. To meet the first of these requirements a ribbed arch with light spandrel columns was designed; to satisfy the second, it was decided not to attempt to finish the concrete surfaces but to provide troughs along and through the structure from which vines might be started to cover the entire showing faces.

Fig. 1 shows the general design of the bridge. It consists of a central arch of 100 ft. span and 15 ft. rise, with a 30-ft. approach on each side. The middle span is made up of three arch ribs, carrying at intervals of 10 ft., light spandrel columns bearing the 16-ft. roadway on a reinforced slab which is continued on independent columns to the approach fills. As lightness of outline was desired for artistic considerations and required for the sake of economy, it was decided to use a three-hinged arch, in which the stresses are so determinate that the limit of lightness can be closely adhered to. The whole structure is of concrete, reinforced slightly near the crown of the arch ribs and completely in the columns and slab. The railing is of a skeleton steel construction which may in future be used as the reinforcement of a concrete railing. In order to insure a concentration of pressure at the crown and haunches the hinges are built pin-connected instead of with the lead face which spreads the thrust over a larger area and makes it more or less indeterminate. Expansion joints are provided in the masonry over both springs, but not at the crown. The details of design are all given on the accompanying figure, so further description is unnecessary.

There has existed at this crossing for some years a timber trestle, with bents of round, white oak and a floor system of squared timber taken from one of the larger city bridges. At the time a new bridge was projected the old timber posts of this trestle had rotted through to the heart wood, and, although with proper repairs the trestle probably would have lasted for four or five years, a consideration of the value of the old trestle as a falsework and working platform led the engineers to expend a larger sum than would have been required for repairs to construct an entirely new bridge.

So in the new construction this old trestle, with some minor modifications, served for centering of the arch rib and as a roadway for the transporting of material, thus obviating the necessity for the use of any hoisting or other machinery and greatly reducing the cost of erection. In addition, the floor of the old bridge was used for the forms for the slabs on the new floor system. No novel features were introduced into the construction except the use of broken-brick concrete for the abutment foundations. The first cost and the cost of hauling were much cheaper for brick than for the stone which was used in the upper works and the concrete made from the former is equally strong as the rotten rock foundations on which the arch foots.

The bridge is to be used only for light vehicular traffic so no sidewalks are provided, and the loads upon which the design was made are only figured as 100 lbs. per sq. ft. with a concentrated load of a 6-ton wagon for the floor. The curve of the arch ring was determined by assuming a dead load, upon which assumption a dead load pressure line was laid out, passing through the center of the hinge-pins, whose position was determined from conditions of the rock footings and the grades. Then two live load pressure lines were drawn, one for a load of 100 lbs. per sq. ft. on one-half of the bridge and the other for a similar load on the other half, thus giving two curves between the hinges, symmetrically placed on either side of a third through



Detail of Floor Slab etc. over Ribs. (Enlarged)
Detail of Flower Troughs. (Enlarged)
Detail of Spandrel Column. (Enlarged)
Detail of Girders, Approach. (Enlarged)
Longitudinal Section.
Cross Section.

FIG. 1. THREE-HINGED CONCRETE BRIDGE ACROSS ROCK CREEK AT ROSS DRIVE, WASHINGTON, D.C.

the same two end points. The upper and lower edges of the ring were then fixed at equal distances from the two outside curves, limiting the depth in the middle to three times the distance between these curves, so as to avoid tension, and, as they approached each other near the hinges, by a limiting compression of 650 lbs. per sq. in. in the outer fiber. Revised calculations, under the loads as built, give an average concrete pressure of 300 lbs. per sq. in. with a maximum of 500 lbs. per sq. in., this latter reduction from 650 lbs. per sq. in. being due to steel in the ring near the crown. There is no tension in the arch ring. Steel in the slabs and beams is stressed to 16,000 lbs. per sq. in. and concrete to 500 lbs. per sq. in.

As has been stated no attempt was made to finish the surface of the concrete, but the connecting struts between the arch ribs were built in box shape (see Fig. 1) so as to serve the double

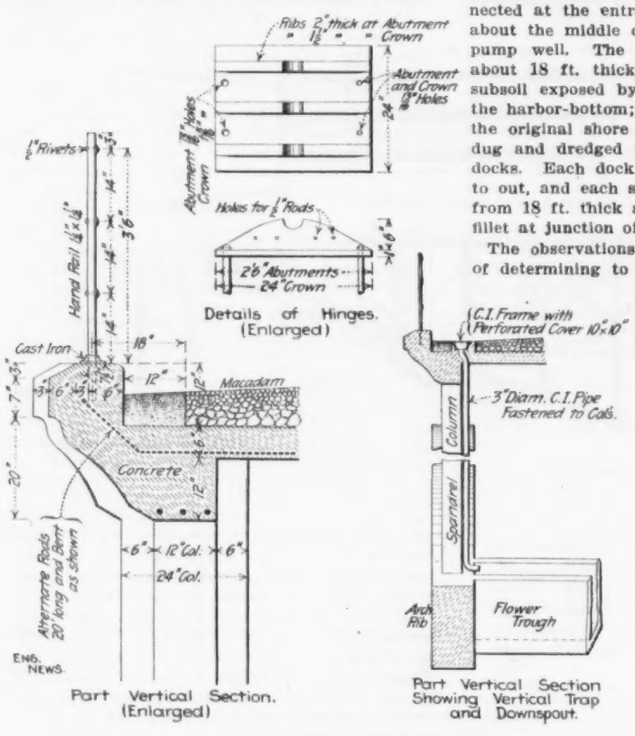


FIG. 2. DETAILS OF THE ROSS DRIVE CONCRETE BRIDGE.

purpose of cross braces and of troughs which, when filled with soil, may be used to grow vines to climb over all the surfaces of the bridge. In addition, the outside foot of the roadway on each side is not to be macadamized, like the rest of the roadway, but is to be filled with soil for the growing of vines.

The site of the bridge is over 5½ miles from the center of the city and especially difficult of access, so cost of labor and material was much higher than in ordinary construction. Laborers were paid 25 cts. extra per day in addition to much extra time going to and from the work; stone and sand cost $2 per load and cement 20 cts. per bbl. just for hauling from the city. Still with all these additional charges, the total cost of the bridge was only $8,000, or about $3 per sq. ft. of roadway surface.

The bridge is under the general supervision of Maj. Jay J. Morrow, U. S. A., Engineer Commissioner, and Capt. E. M. Markham, U. S. A., Asst. Engineer Commissioner of the District of Columbia. It was designed in the office of Mr. W. J. Douglas, M. Am. Soc. C. E., Engineer of Bridges of the District of Columbia, and erected under his charge by Mr. W. P. Darwin, Asst. Engineer of Bridges, and Mr. W. R. Lapham, Superintendent. We are indebted to Mr. Douglas for the drawings and data of this article.

ELASTIC VERTICAL MOTIONS OF THE KIEL DRYDOCKS.

Vertical motions of the large concrete drydocks at Kiel, Germany, have been observed by Harbor Engineer O. Franzius of Kiel, as reported by him in an article in the government journal, "Zeitschrift für Bauwesen." These docks are very heavy, and rest on a deep stratum of fine sand, without piling. The up-and-down movement which has been observed in them is instructive in its bearing on questions of foundation work and elasticity of foundation strata.

The Kiel drydocks were described at considerable length in our issue of Dec. 3, 1903, pp. 494-498. They comprise two dock chambers, numbered V and VI, lying side by side with a clear distance of 75 ft. between them. Each chamber has a usable length of 574 ft., a width of 98.4 ft. at the entrance, and a normal depth of water of 36.4 ft. They are built of concrete with inner facing of masonry. The two chambers are connected at the entrance by a concrete wall and about the middle of their length by a concrete pump well. The bottom of each chamber is about 18 ft. thick, resting directly on a sand subsoil exposed by dredging away the mud of the harbor-bottom; the inshore portion cuts into the original shore line, and here the bank was dug and dredged away to make room for the docks. Each dock chamber is 133 ft. wide out to out, and each side wall, therefore, is not far from 18 ft. thick at the base (not counting the fillet at junction of sidewall and base).

The observations were begun for the purpose of determining to what extent the floor of the dock changes shape when full of water or when carrying a docked vessel, as compared with the shape of the floor of the empty dock. By careful leveling it was found that by filling the dock the bottom was bent downward along the longitudinal center line at each cross-section; or, referencing the motion to the floor of the full dock, the floor bent upward when the dock was pumped out. Since the blocking for a ship about to be docked is leveled up in the empty dock, a change of shape resulting from the weight of the water or the weight of the ship alone might give rise to trouble. But the amount of the bending was found to be too small to be of influence in this regard.

In actual figures, the downward bending of the middle with respect to points close to the sidewalls, at different cross-sections, varied from zero at the entrance to 0.24 in. at the inner end for Dock VI, and 0.79 in. for Dock V. Intermediate cross-sections showed amounts of bending roughly proportional to their distance from the outer end. The weight of a 14,000-ton battleship produced a bending of about 0.78-in. at the inner end of Dock V and 0.16-in. at the inner end of Dock VI., or practically the same distortion as produced by the weight of the entire charge of water, weighing nearly five times as much.

Mr. Franzius does not attribute this bending to distortion of the floor or base as a whole, because this would produce canting of the side-walls, whereas careful observation with a transit indicated entire absence of such canting. He concludes that the distortion is chargeable to the upper or surfacing layer of the concrete, 16 ins. thick, which was placed independently of the main portion of the base. When the docks were built, rather troublesome springs were encountered in the substratum; they were finally drained to a sump at the pump-well. He believes that these springs produce a hydrostatic pressure in the space between the main part of the base and the surfacing layer, which bends the latter upward when the dock is empty, but is overcome by the superincumbent load when the dock is full of water or a ship rests on the bl[illegible].

There is a longitudinal crack in the concrete bottom of Dock V, extending partway through the inshore end wall. The author does not, however, charge this with the much larger bending in Dock V, as compared with its neighbor, but seeks the explanation in the fact that a larger flow of water was struck in the for[illegible].

More interesting than the study of the bending, however, is the further observation that the entire dock structure sinks downward when water is admitted and rises when the water is pumped out. A series of careful levels was run on Dock VI to determine the amount of this motion.

Complete filling caused the dock to settle downward 0.20-in. at the entrance, and 0.18-in. at the inshore end. The weight of a 12,000-ton ship produced a smaller settlement, 0.10-in. at the entrance and practically zero at the inshore end. Upon pumping out the water (or ship in dock), a rising was observed which amounted to 0.18-in. by the time the dock was empty, and in 26 hours more had increased to the full amount of the previous settlement.

Franzius attributes the vertical motion wholly to the compressibility of the subsoil. The concrete base rests on a layer of extremely fine sand with a small proportion of somewhat larger grains, and this stratum is of considerable depth, not penetrated by borings 30 ft. below the foundation level. The empty dock, weighing about 188,000 tons, with a base area of 80,000 sq. ft., produces a foundation pressure of about 2.4 tons per sq. ft. The full hydrostatic uplift would amount to 1.6 tons per sq. ft., so that the dock is not buoyant. The settlement must, therefore, find its explanation in the yielding of the soil under increased load.

Two related observations are noted by the author. (1) One end of a large lock at Bremerhaven moves up and down with the changing tide somewhat as the Kiel drydock moves (there is practically no tide at Kiel). (2) A new large elevated tank of the Bremen water-works, when filled, was found to have settled 0.18-in.; when the tank was emptied the structure again rose 0.08-in. The intensity of loading is not given for these cases.

GENERAL PRACTICE IN ROADBED OILING was summarized by Mr. J. C. Rockold, Assistant Roadmaster of the Santa Fe Coast Lines, in a letter read before the last convention of the Roadmasters and Maintenance-of-Way Association of America. He gave it as the consensus of opinion of maintenance-of-way officials that track should be oiled once a year, preferably during the hot, dry season, as the process effectually lays the dust and, solidifying the surface, makes it impervious to water. It follows that the work should be done only after the ties have been put in and the surfacing is complete, in order that the oiled coating may not be disturbed. The objection that in clayey soil the oil fails to penetrate and, settling around the ties, combines with rain water to produce churning at the joints, is overcome by the practice of replacing such clay with a ballast of gravel or of the volcanic cinder so plentiful along the desert roads which are most benefited by oiling. Results will justify the expense. Plain crude oil is used at a cost of 18 cts. per barrel. Total expenses per mile approximate as follows:

60 barrels of oil	$10.80
Work train service	.70
Sanding and cleaning oil off rails, miscellaneous labor	.375
Total cost of oiling roadbed, per mile	$11.875

The work is done by an ordinary oil car with a sprinkling attachment at its bottom outlet consisting of a 2½ or 3-in. gas pipe perforated with ¾-in. holes spaced ¾ in. apart, and provided with joints to permit swinging around curve stakes, wing fences, posts, etc. The effect of oil on ties is preservative if care is taken to apply it to dried and treated ties before they have a chance to absorb moisture. Fire risk is not increased, as the volatile ingredients quickly evaporate. A strong argument in favor of its use, and one which should be given weight opposite the expense account, is its destructive effect on weeds. Regular application will give a superior, dustless roadbed.

THE CONFERENCE ON THE CONSERVATION OF NATURAL RESOURCES.

(With full-page plate.)

There was convened at Washington last week at the call of President Roosevelt, a most important assemblage dealing with the most momentous question that has arisen since the Federal Constitution was adopted. The question of preserving the gifts of Nature from waste and destruction lies at the foundation of future national prosperity. Upon it, indeed, depends the future existence of the human race and the perpetuity of civilization in its present form.

In the popular thought, the gifts of Nature are illimitable. Very few understand how limited and small is the area of fertile soil and of productive mineral deposits on which, in the last analysis, the whole human race depends for the means of subsistence. A few scientists and engineers, however, are conversant with the facts and it is due to the zeal and initiative of a few far-seeing men of this stamp in the Government service that the interest of President Roosevelt was enlisted in the great question and the conference was brought together.

Invitations to this conference were sent to the Governor of each State, and each was invited to bring with him three citizens of his own State conversant with the subjects to be discussed. Invitations were also sent to the members of the Cabinet and the Supreme Court, to the Senators and Representatives in Congress and to the Presidents of about 50 of the principal technical, industrial and professional organizations of national scope. Included in this list were the most important of the National engineering societies.

On the morning of May 13, the delegates, in number about 400, assembled in the famous East Room of the White House where a temporary rostrum had been prepared. The members of the Cabinet were seated on the platform at the right and the Judges of the Supreme Court on the left. Seldom in our history has an assemblage including so many men of national distinction been brought together. At 11 a. m. the assembly rose at the strains of the National anthem and President Roosevelt was escorted to the chair. Beside him stood the venerable Dr. Edward Everett Hale, the Chaplain of the Senate, who at a word from the President recited passages of Scripture peculiarly appropriate to the subject of the conference and then led the assembly in the Lord's Prayer.

The President then opened the conference with an address which will rank among the most important state papers of his administration. It was delivered with a force and an earnestness that deeply impressed every member of the conference, and convinced them not alone of the importance of the problem, but of the sincere zeal for the public welfare which had animated the President in issuing the invitation to the Governors and their advisers. We reprint a large part of the address as follows:

Governors of the several States; and gentlemen:

I welcome you to this conference at the White House. You have come hither at my request so that we may join together to consider the question of the conservation and use of the great fundamental sources of wealth of this nation. So vital is this question, that for the first time in our history the chief executive officers of the States separately, and of the States together forming the nation, have met to consider it.

With the governors come men from each State chosen for their special acquaintance with the terms of the problem that is before us. Among them are experts in natural resources and representatives of national organizations concerned in the development and use of these resources; the Senators and Representatives in Congress; the Supreme Court, the Cabinet, and the Inland Waterways Commission have likewise been invited to the conference, which is therefore national in a peculiar sense. This conference on the conservation of natural resources is in effect a meeting of the representatives of all the people of the United States called to consider the weightiest problem now before the nation; and the occasion for the meeting lies in the fact that the natural resources of our country are in danger of exhaustion if we permit the old wasteful methods of exploiting them longer to continue.

Nature has supplied to us in the United States, and still supplies to us, more kinds of resources in a more lavish degree than has ever been the case at any other time or with any other people. Our position in the world has been attained by the extent and thoroughness of the control we have achieved over nature; but we are more, and not less, dependent upon what she furnishes than at any previous time of history since the days of primitive man.

Our fathers, though they knew little of the resources of the country, exercised a wise forethought in reference thereto. Washington clearly saw that the perpetuity of the States could only be secured by union, and that the only feasible basis of union was an economic one; in other words, that it must be based on the development and use of their natural resources. Accordingly, he helped to outline a scheme of commercial development, and by his influence an interstate waterways commission was appointed by Virginia and Maryland.

It met near where we are now meeting, in Alexandria, adjourned to Mt. Vernon, and took up the consideration of interstate commerce by the only means then available, that of water. Further conferences were arranged, first at Annapolis, and then at Philadelphia. It was in Philadelphia that the representatives of all the States met for what was in its original conception merely a waterways conference; but when they had closed their deliberations the outcome was the Constitution which made the States into a nation.

The Constitution of the United States thus grew in large part out of the necessity for united action in the wise use of one of our natural resources. The wise use of all our natural resources, which are our national resources as well, is the great material question of today.

I have asked you to come together now because the enormous consumption of these resources, and the threat of imminent exhaustion of some of them, due to reckless and wasteful use, once more calls for common effort, common action.

This nation began with the belief that its landed possessions were illimitable and capable of supporting all the people who might care to make our country their home, but already the limit of unsettled land is in sight, and indeed, but little land fitted for agriculture now remains unoccupied, save what can be reclaimed by irrigation and drainage. We began with an unapproached heritage of forests; more than half of the timber is gone. We began with coal fields more extensive than those of any other nation, and with iron ores regarded as inexhaustible, and many experts now declare that the end of both iron and coal is in sight.

The mere increase in our consumption of coal during 1907 over 1906 exceeded the total consumption in 1876, the Centennial year. The enormous stores of mineral oil and gas are largely gone. Our natural waterways are not gone, but they have been so injured by neglect and by the division of responsibility and utter lack of system in dealing with them, that there is less navigation on them now than there was fifty years ago.

Finally, we began with soils of unexampled fertility and we have so impoverished them by injudicious use and by failing to check erosion that their crop producing power is diminishing instead of increasing.

In a word, we have thoughtlessly, and to a large degree unnecessarily, diminished the resources upon which not only our prosperity but the prosperity of our children must always depend.

We have become great because of the lavish use of our resources and we have just reason to be proud of our growth. But the time has come to inquire seriously what will happen when our forests are gone, when the coal, the iron, the oil, and the gas are exhausted, when the soils shall have been still further impoverished and washed into the streams, polluting the rivers, denuding the fields, and obstructing navigation. These questions do not relate only to the next century or to the next generation. It is time for us now as a nation to exercise the same reasonable foresight in dealing with our great natural resources that would be shown by any prudent man in conserving and widely using the property which contains the assurance of well-being for himself and his children.

Neither the primitive man nor the pioneer was aware of any duty to posterity in dealing with the renewable resources. When the American settler felled the forests, he felt that there was plenty of forest left for the sons who came after him. When he exhausted the soil of his farm he felt that his son could go West and take up another. So it was with his immediate successors. When the soil-wash from the farmer's fields choked the neighboring river he thought only of using the railway rather than boats for moving his produce and supplies.

Now all this is changed. On the average the son of the farmer of today must make his living on his father's farm. There is no difficulty in doing this if the father will exercise wisdom. No wise use of a farm exhausts its fertility. So with the forests. We are over the verge of a timber famine in this country, and it is unpardonable for the nation or the States to permit any further cutting of our timber save in accordance with a system which will provide that the next generation shall see the timber increased instead of diminished. Moreover, we can add enormous tracts of the most valuable possible agricultural land to the national domain by irrigation in the arid and semiarid regions and by drainage of great tracts of swamp land in the humid regions. We can enormously increase our transportation facilities by the canalization of our rivers so as to complete a great system of waterways on the Pacific, Atlantic and Gulf coasts and in the Mississippi Valley, from the Great Plains to the Alleghanies and from the northern lakes to the mouth of the mighty Father of the Waters. But all of these various uses of our natural resources are so closely connected that they should be coordinated, and should be treated as part of one coherent plan and not in haphazard and piecemeal fashion.

It is largely because of this that I appointed the Inland Waterways Commission last year and that I have sought to perpetuate its work. I wish to take this opportunity to express in heartiest fashion my acknowledgment to all the members of the commission. At great personal sacrifice of time and effort they have rendered a service to the public for which we cannot be too grateful. Especial credit is due to the initiative, the energy, the devotion to duty, and the far-sightedness of Gifford Pinchot, to whom we owe so much of the progress we have already made in handling this matter of the coordination and conservation of natural resources. If it had not been for him this convention neither would have been nor could have been called.

We are coming to recognize as never before the right of the nation to guard its own future in the essential matter of natural resources. In the past we have admitted the right of the individual to injure the future of the Republic for his own present profit. The time has come for a change. As a people we have the right and duty, second to none other but the right and duty of obeying the moral law, of requiring and doing justice, to protect ourselves and our children against the wasteful development of our natural resources, whether that waste is caused by the actual destruction of such resources or by making them impossible of development hereafter.

Any right thinking father earnestly desires and strives to leave his son both an untarnished name and a reasonable equipment for the struggle of life. So this nation as a whole should earnestly desire and strive to leave to the next generation the national honor unstained and the national resources unexhausted. There are signs that both the Nation and the States are awaking to a realization of this great truth.

On March 10, 1908, the Supreme Court of Maine rendered an exceedingly important judicial decision. This opinion was rendered in response to questions as to the right of the legislature to restrict the cutting of trees on private land for the prevention of droughts and floods, the preservation of the natural water supply, and the prevention of the erosion of such lands, and the consequent filling up of rivers, ponds and lakes. The forests and water power of Maine constitute the larger part of her wealth and form the basis of her industrial life, and the question submitted by the Maine Senate to the Supreme Court and the answer of the Supreme Court alike bear testimony to the wisdom of the people of Maine, and clearly define a policy of conservation of natural resources, the adoption of which is of vital importance not merely to Maine but to the whole country.

The opinion of the Maine supreme bench sets forth unequivocally the principle that the property rights of the individual are subordinate to the rights of the community, and especially that the waste of wild timber land derived originally from the State, involving as it would the impoverishment of the State and its people and thereby defeating one great purpose of government, may properly be prevented by State restrictions.

The court says that there are two reasons why the right of the public to control and limit the use of private property is peculiarly applicable to property in land:

> First, such property is not the result of productive labor, but is derived solely from the State itself, the original owner; second, the amount of land being incapable of increase, if the owners of large tracts can waste them at will without State restriction, the State and its people may be helplessly impoverished and one great purpose of government defeated. * * * We do not think the proposed legislation would operate to "take" private property within the inhibition of the Constitution. While it might restrict the owner of wild and uncultivated lands in his use of them, might delay his taking some of the product, might delay his anticipated profits and even thereby might cause him some loss of profit, it would nevertheless leave him his lands, their product and increase, untouched, and without diminution of title, estate, or quantity. He would still have large measure of control and large opportunity to realize values. He might suffer delay but not deprivation. * * * The proposed legislation * * * would be within the legislative power and would not operate as a taking of private property for which compensation must be made.

The Court of Errors and Appeals of New Jersey has adopted a similar view, which has recently been sustained by the Supreme Court of the United States. In delivering the opinion of the court on April 6, 1908, Mr. Justice Holmes said:

> The State as quasi-sovereign and representative of the interests of the public has a standing in court to protect the atmosphere, the water, and the forests within its

territory, irrespective of the assent or dissent of the private owners of the land most immediately concerned. * * * It appears to us that few public interests are more obvious, indisputable and independent of particular theory than the interest of the public of a State to maintain the rivers that are wholly within it substantially undiminished, except by such drafts upon them as the guardian of the public welfare may permit for the purpose of turning them to a more perfect use. This public interest is omnipresent wherever there is a State, and grows more pressing as population grows. * * * We are of opinion, further, that the constitutional power of the State to insist that its natural advantages shall remain unimpaired by its citizens is not dependent upon any nice estimate of the extent of present use or speculation as to future needs.

The legal conception of the necessary is apt to be confined to somewhat rudimentary wants, and there are benefits from a great river that might escape a lawyer's view. But the State is not required to submit even to an aesthetic analysis. Any analysis may be inadequate. It finds itself in possession of what all admit to be a great public good, and what it has, it may keep and give no one a reason for its will.

These decisions reach the root of the idea of conservation of our resources in the interests of our people.

Finally, let us remember that the conservation of our natural resources, though the gravest problem of today, is yet but part of another and greater problem to which this Nation is not yet awake, but to which it will awake in time, and with which it must hereafter grapple if it is to live—the problem of national efficiency, the patriotic duty of insuring the safety and continuance of the Nation. When the people of the United States consciously undertake to raise themselves as citizens, and the Nation and the States in their several spheres, to the highest pitch of excellence in private, State, and national life, and to do this because it is the first of all the duties of true patriotism, then, and not till then, the future of this Nation, in quality and in time, will be assured.

President Roosevelt's address made a deep impression on all the members of the conference. It sounded a keynote of devotion to the public interest and of patriotic provision for the welfare of posterity, which was maintained and emphasized throughout all the following sessions of the conference.

The morning session concluded with a reception by the President, following which the Governors, members of the Cabinet and Supreme Court and other distinguished men among the delegates were photographed on the portico of the White House. This photograph is reproduced on an inset sheet in this issue.

Each session of the conference was opened with President Roosevelt as the presiding officer, but to attend to other duties he relinquished the chair later to some one of the Governors present. Before the conclusion of the Wednesday morning session a Committee on Resolutions was elected, consisting of Governors Blanchard of Louisiana, Fort of New Jersey, Davidson of Wisconsin, Cutler of Utah and Ansel of South Carolina. It was voted that all resolutions be referred to this committee without debate.

MINERAL RESOURCES.

The session of Wednesday afternoon was devoted to the conservation of mineral wealth and opened with a paper by Andrew Carnegie. Extracts follow:

Iron and coal are the foundation of our industrial prosperity. In modern times the manufacturing and transportation industries rest upon them, and, given sufficient land area and fertile soil, these determine the progress of any people.

When the Republic was founded, there were, according to recent expert estimates, approximately 2,000,000,000,000 tons of coal in the territory now forming the United States. Practically none of this supply was used for over a quarter-century; but during the 75 years from 1820 to 1895 nearly 4,000,000,000 tons were mined by methods so wasteful that some 6,000,000,000 tons were either destroyed or allowed to remain in the ground, forever inaccessible. During the 10 years from 1896 to 1906 as much was produced as during the preceding 75 years; while more than 3,000,000,000 tons were destroyed or left in the ground beyond reach of future use. To date the actual consumption of coal has been over 7,500,000,000 tons; the waste and destruction in the neighborhood of 9,000,000,000 tons. If mining were perfected from now forward, we might reckon that considerably less than 1% of our original stock has been consumed; but estimating on the basis of the wasteful methods hitherto pursued, nearly 2% of our available supply is gone.

Coal consumption is increasing at an astonishing rate. During the period for which statistics have been gathered, it has doubled during each decade; of late it has more than doubled. In 1907 the production was about 450,000,000 tons, or over five tons per capita for our entire population.

All estimates of future consumption and destruction of coal are liable to error, yet making all reasonable allowance, unless there be careful husbanding, or revolutionizing inventions, or some industrial revolution comes which cannot now be foreseen, the greater part of that estimated 2,000,000,000,000 tons of coal forming our original heritage will be gone before the end of the next century, say two hundred years hence.

To each generation the ultimate disappearance of coal is of less concern than current prices. Already this is felt; it is estimated that by reason of the progressive exhaustion of American fields, coal consumers are to-day paying on an average of 10% or 15% more than would be necessary if the supply were unlimited—and the advance must continue with each decade as the supply lessens.

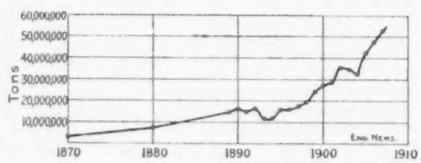
Still more wasteful than our processes of mining are our methods of consuming coal. Of all the coal burned in the power-plants of the country, not more than from 5% to 10% of the potential energy is actually used; the remaining 90% to 95% is absorbed in rendering the smaller fraction available in actual work.

The same spirit of recklessness that leads to waste in mining and in the consumption of coal leads to unnecessary risk of human life. During the year 1907 in the United States the killed and wounded in coal mining operations exceeded 9,000. The danger to life and limb in the mines is increasing far more rapidly than production.

When the Republic was started in 1776 little iron was used. Each family was content with a few score pounds in the form of implements, utensils, and weapons, so that the average annual consumption was but a few pounds per capita. In 1907 alone the production of iron ore in the United States was 53,000,000 tons, or more than 1,200 pounds for each man, woman and child of our 88,000,000 population. And the production is steadily increasing.

The latest trustworthy estimates of our present stock of iron ore are: for the Lake Superior district, about 1,500,000,000 tons; for the Southern district (including Alabama, Georgia, Tennessee and Virginia), about 2,500,000,000 tons; and for the rest of the United States 5,000,000,000 to 7,000,000,000 tons—making an aggregate of about 10,000,000,000 tons.

Our highest grade ore is that of the Lake Superior district, which yields about four-fifths of the current production. In 1905 its yield was over 33,000,000 tons, in 1906 some 38,000,000 tons, and in 1907 nearly 44,000,000 tons; by the end of the present decade it will average 50,000,000 tons or more. Even without further increase, the known supply will be exhausted before 1940. It is true that there are frequent reports of new ore bodies in this district; but, on the other hand, the old bodies generally run far below the estimates.



Pig Iron Production in the United States.

The total production of iron ore in the United States up to 1890 was some 275,000,000 tons; in the next ten years it was nearly 200,000,000; and in the seven years from 1901 to 1907 over 270,000,000 tons were produced, or very nearly as much as the total for the first century of our history. The aggregate production to date, 750,000,000 tons, is about one-thirteenth of the estimated original supply. At the recent rate of increase (doubling each decade) the production in 1918 will exceed 100,000,000 tons; by 1928, 200,000,000 tons, and by 1938 it will be over 400,000,000 tons—i. e., in that single year, which many of us may expect to see, an amount approximating the entire production in the United States during the last century. By that date about half of the original supply will be gone, and only the lower grades of ore will remain; and all the ore now deemed workable will be used long before the end of the present century.

Compared with Britain or Germany, our only two important competitors in iron and steel, we were until the past few years in much more favorable condition. Britain then was apparently within twenty years of her end as an important steel producer, owing to exhaustion of her ore supplies. Recent discoveries in northern Sweden have given her a new lease and also benefited Germany, both of which are already drawing part of their supply from the new mines which are said to be by far the most extensive ever known. The ores are of excellent quality. It is not improbable that ere long we also in the Eastern States shall be compelled to rely upon these deposits for part of our supply.

The additional cost of ore due to progressive exhaustion of the bodies of ore can hardly be estimated at less than 10%; this is already felt, and must increase as field after field is exhausted.

I have for many years been impressed with the steady depletion of our iron ore supply. It is staggering to learn that our once supposed ample supply of ores can hardly outlast the generation now appearing, being only the leaner ores for the later years of the century. It is my judgment, as a practical man accustomed to dealing with those material factors on which national prosperity is based, that it is time to take right for the morrow. I fully concur in the opinion of the President that the state of our resources raises one of the most serious issues now before the American people, and hope that this national meeting will lead to wise action.

We are nationally in the position of a large family receiving a rich patrimony from thrifty parents; the President may be likened to the eldest son, and the Governors to younger brothers, jointly responsible for the minors; the experts assembled may be likened to the family solicitors. Now, the first duty of such a family is to take stock of its patrimony; the next to manage the assets in such manner that none shall be wasted, that all be put to the greatest good of the living and their descendants. Now we have just begun to take stock of our national patrimony; and it is with the deepest sense of responsibility imposed on me by the invitation to this meeting, to the nation and to coming generations of all time, that I speak as one of the junior solicitors. In my opinion, we should watch closely all the assets and begin both to save and to use them more wisely.

Let us begin with iron: We must in all possible ways lessen the demands upon it, for it is with iron ore we are least adequately provided. One of the chief uses of this metal is connected with transportation, mainly by rail. Moving 1,000 tons of heavy freight by rail requires an 80-ton locomotive and twenty-five 20-ton steel cars (each of 40-ton capacity), or 580 tons of iron and steel, with an average of say ten miles of double track with 90-lb. rails, or 317 tons additional; so that including switches, frogs, fish-plates, spikes and other incidentals, the carriage requires the use of an equal weight of metal. The same freight may be moved by water by means of 100 to 250 tons of metal, so that the substitution of water-carriage for rail-carriage would reduce the consumption of iron by three-fourths to seven-eighths in this department. At the same time the consumption of coal for motive power would be reduced 50% to 75%, with a corresponding reduction in the coal required for smelting. No single step open to us to-day would do more to check the drain on iron and coal than the substitution of water-carriage for rail-carriage wherever practicable, and the careful adjustment of the one to the other throughout the country.

The next great use of iron is in construction, especially of buildings and bridges. Fortunately the use of concrete, simple and reinforced, is already reducing the consumption of structural steel.

A large current use of steel of the highest quality is for battleships, ordnance, projectiles and small arms. Happily there are signs of an awakening of the public conscience and of the sense of national righteousness, whereby civilized nations must be led to adopt those moral standards which already regulate individual conduct; the world is soon to learn that war is not only too disgracefully inhuman but too wasteful to be tolerated, and this serious drain upon our iron ores will cease.

The most serious waste arises from imperfect combustion in furnace and fire-box. We have already learned that internal-combustion engines and gas producers double or triple the power per unit of coal, obviate the smoke nuisance and also permit the use of lignite, culm, slack and inferior coals. Much of our coke-making is still extravagant; some ovens use the gases, and all should do so without delay—if necessary, under State regulation.

Next to imperfect combustion, the chief waste of coal arises in mining. It was years after mining began before coal lands were thought to have any other value than as wood-lands or farm-lands. Thus the incredibly wasteful methods were natural enough; if labor could be saved and profit gained by taking out but a third or a half of the richest part of the seam, leaving the rest to be rendered inaccessible by caving, so be it. No one thought of it as improvident. Now that the coal in the ground is recognized as part, and a great part, of the value of coal lands, self-interest impels the operator to take out all he can, and leads the miner to work close to floor and roof. Coal mining cries out for expert knowledge whereby the full yield may be obtained without needless risk or loss; and for wise police regulation whereby life may be protected against ignorance and cupidity.

The most promising check on coal consumption is the substitution of other power. It is only within the past decade that electrical transmission has made water power generally available for driving machinery, for smelting, and for moving trains, and has at the same time created a new market for copper; yet it is a safe forecast that this method of using solar energy (for water power is the product of sun heat) will soon affect the constantly increasing drain on our coal.

No practical man can study our mineral supplies without seeing that they are melting away under our national growth at a geometrically increasing rate, and without realizing that unless the loss is checked his descendants must suffer; nor can he consider ways of preserving the supply without realizing the need of wider and deeper knowledge than we now possess. I plead for economy, that the next generation and the next may be saved from want; especially I urge research into and mastery over nature, in order that two blades may be made to grow where one grew before, that the golden grain may be made to replace woody grass, that crude rocks may be made to yield fine metals.

I look on the Executives here assembled as our greatest need to-day the need for better and more practical knowledge. If our career of prosperity is to continue, it must be on the basis of completer control of national sources of material and power than we have thus far exercised, a control to be gained only by research.

In conclusion, Mr. President and Governors of our States, it seems to me our duty is:

First, conservation of forests, for no forests, no long navigable rivers; no rivers, no cheap transportation.

Second, to systematize our water transportation, putting the whole work in the hands of the Reclamation Service, which has already proved itself highly capable by its admirable work.

Third, conservation of soil. More than a thousand millions of tons of our richest soil are swept into the sea every year, clogging the rivers on its way and filling our harbors. Less soil, less crops; less crops, less commerce, less wealth.

Our President, with far-sighted patriotism, has arisen to lead effort and action. He deserves, and I am sure will receive, your earnest support and that of all citizens who understand the importance of the problems involved.

WASTE OF NATURAL GAS.

Mr. J. C. White, State Geologist of West Virginia, followed with a paper entitled "The Waste of Our Fuel Resources." Regarding coal he repeated the statistics of waste in mining and in use given by Mr. Carnegie, declaring that on the average in the mining of our coal fields from 40 to 70% of the contents of the bed is left in the ground and is rendered forever irrecoverable. Taking the Pittsburg coal field as an illustration, Mr. White gave figures showing that if the present rate of coal consumption were to remain stationary the fuel in the Pittsburg coal bed in the State of Pennsylvania will all be exhausted in 93 years. Regarding extravagant predictions of the amount of coal remaining unmined in the Appalachian basin, he gave the following important information:

The productive coal area of the Appalachian basin has been greatly over-estimated, in every one of the six great states through which it passes from Pennsylvania to Alabama. The drill of the seeker for petroleum and natural gas, while it has wasted untold millions of precious fuel, has taught one useful lesson, viz.: that there is a wide area 50 to 75 miles in breadth deep down in the center of the Appalachian basin, that is practically barren of commercial coal. This barren area begins with the lower measures just north from Pittsburg, and embracing large portions of the former supposed coal fields of both Ohio and West Virginia, passes southwestward into Kentucky, having a bread'h of 25 miles where it enters that state.

To what extent the productive area of Kentucky, Tennessee and Alabama will be affected by the southward extension of this barren belt which has already cut the former estimates of Pennsylvania, Ohio and West Virginia in half, we do not yet know, but certain it is that all the great coal formations instead of holding productive coal entirely across this great basin as formerly supposed, are productive only as fringes 20 to 30 miles in breadth around the borders of the basin, while the great central trough is practically destitute of valuable coal. Hence with only a reasonable estimate for increased coal production, if the present wasteful mining methods continue, *there will be but little coal for manufacturing purposes within 100 miles of Pittsburg at the opening of the next century*, and practically no cheap fuel left in the entire Appalachian basin with which to maintain our supremacy in the iron and steel trade of the world.

Mr. White's statements regarding waste of natural gas, however, were even more striking than his story of failing coal resources. We print a large part of this as follows:

Let us consider how we have wasted Natural Gas, the purest form of fuel, ideal in every respect, self-transporting, only awaiting the turning of a key to deliver to our homes and factories, heat and light, and power. Partial Nature has apparently denied this great boon to many other lands. It is practically unknown in France, Germany and Great Britain, our chief competitors in the world of industry. Here is a fuel of which nature has given us a practical monopoly, lavish in abundance and stored under vast pressure to be released wherever wanted at our bidding. The record of waste of this our best and purest fuel is a national disgrace.

At this very minute this unrivaled fuel is passing into the air within our domain from uncontrolled gas wells, from oil wells, from giant flambeaus, from leaking pipe lines and the many other methods of waste at the rate of not less than one billion cubic feet daily and probably much more.

Very few appear to realize either the great importance of this hydro-carbon fuel resource of our country, or its vast original quantity. In my humble opinion the original amount of this volatile fuel in the United States, permeating as it does every undisturbed geologic formation from the oldest to the most recent, rivaled or even exceeded in heating value, all of our wondrous stores of coal.

Suppose that it were possible for some Nero inspired by a mania of incendiarism, to apply a consuming torch to every bed of coal that crops to the surface from the Atlantic to the Pacific, and that the entire coal supply of the Union was threatened with destruction within a very few years, what do you think would happen? Would our State Legislatures sit undisturbed panoplied by such a carnival of fire? Would the Governors of 30 states remain silent while the demon of flame was ravaging the coal resources of the Republic? Certainly not; there would be a united effort by the Governors and Legislatures of all the states in the Union to stay the progress of such a direful conflagration; even the sacred Constitutional barriers wisely erected between State and Federal authority would melt away in the presence of such an awful calamity, and the mighty arm of the Nation would be invoked to help end the common peril to every interest.

And yet this imaginary case is an actual one with the best and purest fuel of the country, equal probably in quantity and value for heat, light and power to all of our coal resources. This blazing zone of destruction extends in a broad band from the Lakes to the Gulf, and westward to the Pacific, embracing in its flaming pathway the most precious fuel possessions of a continent. No one can even approximate the extent of this waste. From personal knowledge of conditions which exist in every oil and gas field, I am sure the quantity will amount to not less than one billion cubic feet daily, and it may be much more. The heating value of a billion cubic feet of natural gas is roughly equivalent to that of one million bushels of coal. What an appalling record to transmit to posterity!

From one well in eastern Kentucky there poured a stream of gas for a period of 20 years without any attempt to shut it in or utilize it, the output of which, it has been figured, was worth at current prices more than three million dollars. Practically the same conditions characterized the first 25 years of Pennsylvania's oil and gas history, and the quantity of wasted gas from thousands of oil and gas wells in western Pennsylvania is beyond computation. In my own state of West Virginia, only eight years ago, not less than 500 million cubic feet of this precious gas was daily escaping into the air from two counties alone, practically all of which was easily preventable, by a moderate expenditure for additional casing. A thousand cubic feet of natural gas weighs 48 lbs. and 6,000 cu. ft. of it would yield a 42-gallon barrel of oil when condensed, so that a well flowing 6,000,000 feet of gas is pouring into the air daily the equivalent of 1,000 barrels of oil. What would our petroleum kings think, if they could see this river of oil (for the equivalent of a billion feet of gas is more than 160,000 barrels of petroleum) rushing unhindered to the sea? Would they not spend millions to check such a frightful waste of this golden fluid? And would they not be the first to appeal to the National Government for aid in ending such great destruction of property? And yet because natural gas is invisible, and its waste is not so apparent to the eye as a stream of oil, or a burning coal mine, the agents of these oil magnates have not only permitted this destruction of the nation's fuel resources to continue, but they have prevented by every means in their power the enactment of any legislation to stop this frightful loss of the best and purest fuel that nature has given to man.

There can be no doubt that for every barrel of oil taken from the earth there have been wasted more than ten times its equivalent in either heating power, or weight even, of this the best of all the fuels, and also that much more than half of this frightful waste could have been avoided by proper care in oil production and slight additional expenditures.

In justice to the great oil-producing corporations, it must be acknowledged that they have not permitted much waste of petroleum except what has been sprayed into the air by the awful waste of gas, and also that their handling of petroleum has been from the beginning, a model of business economy and management. The great mistake of the oil-producing interests has been in not properly apprehending the enormous fuel value of the natural gas they were destroying, and in not demanding legislation for its protection instead of successfully throttling and preventing it in every state of the Union except one—Indiana. When the people of that great state awoke to the fact that their richest mineral possession was being rapidly wasted, they rose to the occasion, and although it was largely a case of "Locking the stable door after the horse had been stolen," they effectually prevented any further useless waste of natural gas. This Indiana statute, which has been declared constitutional by our highest courts, says in effect to the oil producers: "You cannot take the oil from the ground where nature has safely stored it, until you provide a method of utilizing the accompanying gas, or volatile oil as well," and it also says to both the producer and consumer of natural gas that "it is against 'Public Policy' to waste this valuable fuel and that it will not be permitted to either party." This Indiana statute for the conservation of petroleum and natural gas should be enacted into law in every state where these precious fuels exist; and why has it not been done? Let the answer be found in the history of my own state where the waste of natural gas has been exceeded only by that of our sister State of Pennsylvania.

For ten years your speaker has appealed in his official capacity as State Geologist to the Legislature of West Virginia to put some check upon this frightful waste of our State's most valuable resource. Three patriotic Governors, including our present able executive, Governor Dawson, have in every biennial message besought the Legislative branch to end this criminal destruction by appropriate legislation, but some unseen power greater than Governors or Legislatures has so far thwarted and palsied every effort to save to the State and the Nation this priceless heritage of fuel, so that although five successive Legislatures have attempted to deal with the question in biennial sessions not an effective line has yet been added to the statutes, and at this very hour not less than 250 million cubic feet of gas, and possibly more than double that quantity is daily being wasted in this one state alone, 80% of which is easily and cheaply preventable.

Why should a few oil producers in their insane haste to get rich quickly, or add to fortunes already swollen beyond safety to the Republic, be permitted thus to despoil the entire country of its choicest fuel?

That celebrated word picture of Lord Macaulay in which he describes a future traveler as standing on a broken arch of London Bridge, in the midst of a vast solitude, sketching the ruins of St. Paul's, may find its substantial counterpart much nearer home than we could wish.

Honorable Governors of the several States, our patriotic President, ever watchful of the Nation's welfare, and of the people's interests, has summoned you to a conference more important to the future of our Great Republic than any council that has ever before met in the history of our country. What will it profit this nation to have won the wreath of industrial supremacy, if in our thirst for gold and sudden riches we permit corporate greed, as well as individual avarice, and selfishness to waste and devastate the very sources of our prosperity? For just as sure as the sun shines, and the sum of two and two is four, unless this insane riot of destruction and waste of our fuel resources which has characterized the past century, shall be speedily ended, our industrial power and supremacy will, after a meteor-like existence, revert before the close of the present century to those nations that conserve and prize at their proper value their priceless treasures of Carbon.

Whatever is possible in the shape of legislation for the protection of our fuel resources should be done by the individual states which you represent. The task before you and your constituencies is indeed formidable. The forces of greed and selfishness are so entrenched behind corporate power and influence, that to attack them may often appear to you as useless as the labors of Sisyphus. But as you love your states and country I adjure you to take up this fight for the conservation of our fuel resources with the determination never to surrender until the forces of greed and avarice which are so rapidly sapping the very foundations of our country's greatness, capitulate, and agree to end the wild riot of destruction that has characterized the past.

Discussion on the general topic was opened with a brief paper by John Mitchell in which he pointed out that the waste of coal in mining and in use was really largely governed by its very low price, and that if coal were sold at a higher price, producers and consumers alike would have a stronger incentive to reduce waste. He also emphasized the waste of human life in the coal mines, contrasting our black record of loss of life with the records of European countries. Other speakers were C. R. Van Hise, President of the University of Wisconsin, and John Hays Hammond, President of the American Institute of Mining Engineers. Mr. Hammond surprised the conference by declaring that our unmined stores of other metallic ores, such as copper, zinc, lead, tin, gold and silver were in

all probability far smaller than our deposits of coal and iron ore. He thought that long before the world's stock of fuel and iron is exhausted a famine would arise in the other useful minerals. Mr. Hammond's high standing as a mining engineer gives the gravest significance to his statement. Gov. Johnson of Minnesota expressed a belief that the Lake Superior iron ore deposits would prove much more extensive than Mr. Carnegie had stated. During the latter part of this session the chair was occupied by Gov. Noel of Mississippi.

THE PRESERVATION OF SOIL AND FORESTS.

Thursday morning's session was devoted to the subject of Land Resources. The opening paper, by Hon. Jas. J. Hill, on "The Natural Wealth of the Land and Its Conservation," was the most weighty and important of any presented during the whole conference. We print a large part of it as follows:

"Of all the sinful wasters of man's inheritance on earth," said the late Professor Shaler, "and all are in this regard sinners, the very worst are the people of America." This is not a popular phrase, but a scientific judgment. It is borne out by facts.

The sum of resources is simple and fixed. From the sea, the mine, the forest and the soil must be gathered everything that can sustain the life of man. Upon the wealth that these supply must be conditioned forever, as far as we can see, not only his progress but his continued existence on earth. How stands the inventory of property for our own people? The resources of the sea furnish less than 5% of the food supply, and that is all. The forests of this country, the product of centuries of growth, are fast disappearing. The best estimates reckon our standing merchantable timber at less than 2,000,000,000,000 feet. Our annual cut is about 40,000,000,000 feet. We are now using annually 500 ft. B. M. of timber per capita, as against an average of 60 ft. for all Europe. The New England supply is gone. The Northwest furnishes small growths that would have been rejected by the lumberman 30 years ago. The South has reached its maximum production and begins to decline. On the Pacific Coast only is there now any considerable body of merchantable standing timber. We are consuming yearly three or four times as much timber as forest growth restores. Our supply of some varieties will be practically exhausted in ten or twelve years; in the case of others, without reforesting, the present century will see the end. When will we take up in a practical and intelligent way the restoration of our forests?

Turning now to one of the only two remaining sources of wealth, the mine, we find it different from the others in an important essential. It is incapable of restoration or recuperation. The mineral wealth stored in the earth can be used only once. When iron and coal are taken from the mine, they cannot be restored; and upon iron and coal our industrial civilization is built. When fuel and iron become scarce and high-priced, civilization, as far as we can now foresee, will suffer as man would suffer by the gradual withdrawal of the air he breathes.

The exhaustion of our coal supply is not in the indefinite future. Estimates of coal deposits still remaining must necessarily be somewhat vague, but they are approximately near the mark. The best authorities do not rate them at much over 2,000,000,000,000 tons. If coal production continues to increase as it has in the last 90 years, the available supply will be greatly reduced by the close of the century. Before that time arrives, however, resort to lower grades and sinking of mines to greater depths will become necessary; making the product inferior in quality and higher in price. Already Great Britain's industries have felt the check from a similar cause, as shown in her higher cost of production. Our turn will begin probably within a generation or two from this time. Yet we still think nothing of consuming this priceless resource with the greatest possible speed. Our methods of mining are often wasteful; and we not only prohibit our industries from having recourse to the coal supplies of other countries, but actually pride ourselves upon becoming exporters of a prime necessity of life and an essential of civilization.

The iron industry tells a similar story. The total of iron ore mined in the United States doubles about once in seven years. It was less than 12,000,000 tons in 1893, over 24,000,000 tons in 1899, 47,740,000 tons in 1906 and over 52,000,000 tons in 1907. In 1850 the pig iron production of the United States amounted to 563,757 tons, or about 50 lbs. per capita. Our production now is over 600 lbs. per capita. We do not work a mine, build a house, weave a fabric, prepare a meal or cultivate an acre of ground under modern methods without the aid of iron. And the supply of this most precious of all the metals is so far from inexhaustible that it seems as if iron and coal might be united in their disappearance from common life.

The large deposits of iron ore in this country are now located. For cheap iron we depend upon the Lake Superior district, because of its high grade, the ease of extracting the ore from the mines and its nearness to cheap transportation. At the rate of over 50,000,000 tons per year, our present consumption, it would require over 2,000,000,000 tons to supply the demand for the next 40 years, supposing it to remain stationary. This would approach the end of all the higher grade ore in large deposits now in sight. The product of other workings would be of inferior quality and higher cost and remote from market.

But production is certain to increase even more rapidly than in the past. A few years ago a Swedish geologist prepared for his government a report which stated that the entire supply of the iron ore in the United States would be exhausted within the present century. The United States Geological Survey declared this an over statement; but here is the conclusion of its own report:

Assuming that the demand for iron ore during the present century may range from 50,000,000 to 100,000,000 tons per year, the Lake Superior district would last for from 25 to 50 years more, if it supplied the entire United States. But counting on the known reserves elsewhere in the United States the ore will last for a much longer period, though, of course, it must necessarily show a gradual but steady increase in value and in cost of mining, along with an equally steady decrease in grade.

The most favorable view of the situation forces the conclusion that iron and coal will not be available for common use on anything like present terms before the end of this century; and our industrial, social and political life must be readjusted to meet the strains imposed by new conditions. Yet we forbid to our consumers access to the stores of other countries, while we boast of our increased exports of that material for want of which one day the nation must be reduced to the last extremity.

We now turn to the only remaining resource of man upon this earth, which is the soil itself. How are we caring for that, and what possibilities does it hold out to the people of future support? We are only beginning to feel the pressure upon the land. The whole interior of this continent, aggregating more than 500,000,000 acres, has been occupied by settlers within the last 50 years. What is there left for the next 50 years? Excluding arid and irrigable areas, the latter limited by nature, and barely enough of which could be made habitable in each year to furnish a farm for each immigrant family, the case stands as follows. In 1906 the total unappropriated public lands in the United States consisted of 792,000,000 acres. Of this area the divisions of Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico and Wyoming contained 195,700,000 acres of surveyed and 500,000,000 acres of unsurveyed land. Little of Alaska is fitted for general agriculture, while practically all of the rest is semi-arid land, available only for grazing or irrigation. We have, subtracting these totals, 50,000,000 acres of surveyed and 36,500,000 acres of unsurveyed land as our actual remaining stock. And 21,000,000 acres were disposed of in 1907. How long will the remainder last? No longer can we say that "Uncle Sam has land enough to give us all a farm."

Equally threatening is the change in quality. There are two ways in which the productive power of the earth is lessened; first by erosion and the sweeping away of the fertile surface into streams and thence to the sea, and second by exhaustion through wrong methods of cultivation. The former process has gone far. Thousands of acres in the East and South have been made unfit for tillage. North Carolina was, a century ago, one of the great agricultural states of the country and one of the wealthiest. To-day as you ride through the South you see everywhere land gullied by torrential rains, red and yellow clay banks exposed where once were fertile fields; and agriculture reduced because its main support has been washed away. Millions of acres, in places to the extent of one-tenth of the entire arable area, have been so injured that no industry and no care can restore them.

Far more ruinous, because universal and continuing in its effects, is the process of soil exhaustion. It is creeping over the land from East to West. The abandoned farms that are now the playthings of the city's rich or the game preserves of patrons of sport, bear witness to the melancholy change.

The same process of deterioration is affecting the farm lands of Western New York, Ohio and Indiana. Where prices of farms should rise by increase of population, in many places they are falling. Between 1880 and 1900 the land values of Ohio shrunk $60,000,000. Official investigation of two counties in Central New York disclosed a condition of agricultural decay. In one, land was for sale for about the cost of improvements and 150 vacant houses were counted in a limited area. In the other the population in 1905 was nearly 4,000 less than in 1855.

Practically identical soil conditions exist in Maryland and Virginia. The richest region of the West is no more exempt than New England or the South. The soil of the West is being reduced in agricultural potency by exactly the same processes which have driven the farmer of the East, with all his advantage of nearness to markets, from the field.

Within the last 40 years a great part of the richest land in the country has been brought under cultivation. We should, therefore, in the same time, have raised proportionately the yield of our principal crops per acre; because the yield of old lands, if properly treated, tends to increase rather than diminish. The year 1866 was one of large crops and can scarcely be taken as a standard. We produced, for example, more corn that year than had ever been grown in the United States in a single year before. But the average yield per acre was *less than it was in* 1872. We are barely holding the acre product stationary. The average wheat crop of the country now ranges from 12½, in ordinary years, to 15 bushels per acre in the best seasons. And it is on down the line.

But the fact of soil waste becomes startlingly evident when we examine the record of some states where single cropping and other agricultural abuses have been prevalent. Take the case of wheat, the typical one of single-crop abuse. In the far West, Kansas takes high rank as a wheat producer. Its average yield per acre for the last ten years was 14.16 bushels. For the first five of those years it was 15.14 and for the last five 13.18. Up in the Northwest, Minnesota wheat has made a name all over the world. Her average yield per acre for the same ten years was 12.96 bushels. For the first five years it was 13.12 and for the last five 12.8. We perceive here the working of a uniform law, independent of location, soil or climate. It is the law of a diminishing return due to soil destruction. Apply this to the country at large, and it reduces agriculture to the condition of a bank whose depositors are steadily drawing out more money than they put in.

What is true in this instance is true of our agriculture as a whole. In no other important country in the world, with the exception of Russia, is the industry that must be the foundation of every state, at so low an ebb as in our own. According to the last census the average annual product per acre of the farms of the whole United States was worth $11.38. It is little more than a respectable rental in communities where the soil is properly cared for and made to give a reasonable return for cultivation. There were but two states in the Union whose total value of farm products was over $30 per acre of improved land. The great state of Illinois gave but $12.48, and Minnesota showed only $8.74. Nature has given to us the most valuable possession ever committed to man. It can never be duplicated, because there is none like it upon the face of the earth. And we are racking and impoverishing it exactly as we are felling the forests and rifling the mines. Our soil, once the envy of every other country, the attraction which draws millions of immigrants across the seas, gave an average yield for the whole United States during the 10 years beginning with 1896 of 13.5 bushels of wheat per acre. Austria and Hungary each produced over 17 bushels per acre, France 19.8, Germany 27.6 and the United Kingdom 32.2 bushels per acre. For the same decade our average yield of oats was less than 30 bushels, while Germany produced 46 and Great Britain 42. For barley the figures are 25 against 33 and 34.6; for rye 15.4 against 24 for Germany and 26 for Ireland. In the United Kindom, Belgium, The Netherlands and Denmark a yield of more than 30 bushels of wheat per acre has been the average for the past five years.

When the most fertile land in the world produces so much less than that of poorer quality elsewhere, and this low yield shows a tendency to steady decline, the situation becomes clear. We are robbing the soil, in an effort to get the largest cash returns from each acre of ground in the shortest possible time and with the least possible labor.

Our agricultural lands have been abused in two principal ways; first by single cropping, and second by neglecting fertilization. It is fortunate for us that nature is slow to anger, and that we may arrest the consequence of this ruinous policy before it is too late. In all parts of the United States, with only isolated exceptions, the system of tillage has been to select the crop which would bring in most money at the current market rate, to plant that year after year, and to move on to virgin fields as soon as the old farm rebelled by lowering the quality and quantity of its return. It is still the practice; although diversification of industry and the rotation of crops have been urged for nearly a century and are to-day taught in every agricultural college in this country.

We frequently hear it said that the reduction in yield is due to the wearing out of the soil as if it were a garment to be destroyed by the wearing. The fact is that soils either increase or maintain their productivity indefinitely under proper cultivation. If the earth, the great mother of human and animal life, is to "wear out," what is to become of the race?

The two remedies are as well ascertained as is the evil. Rotation of crops and the use of fertilizers act as tonics upon the soil. We might expand our resources

and add billions of dollars to our national wealth by conserving soil resources, instead of exhausting them as we do the forests and the contents of the mines.

I have dwelt upon the conservation of farm resources because of the commanding importance of this industry and because of its relation to our future. Nearly 36% of our people are engaged directly in agriculture. But all the rest depend upon it. In the last analysis, commerce, manufactures, our home market, every form of activity runs back to the bounty of the earth by which every worker, skilled and unskilled, must be fed and by which his wages are ultimately paid. The farm products of the United States in 1906 were valued at $6,793,000,000 and in 1907 at $7,412,000,000. All of our vast domestic commerce, equal in value to the foreign trade of all the nations combined, is supported and paid for by the land. Of our farm areas only one-half is improved. It does not produce one-half of what it could be made to yield; not by some complex system of intensive culture, but merely by ordinary care and industry intelligently applied.

Nowhere in the range of national purposes is the reward for conservation of a national resource so ample. Nowhere is the penalty of neglect so threatening.

By the fixed rate of increase in the past we shall have about 130,000,000 people in 1925 and at least 200,000,000 by the middle of the century. Where are they to go, how are they to be employed, how fed, how enabled to earn a living wage? The pressure of all the nations upon the waste places of the earth grows more intense as the last of them are occupied. We are approaching the point where all our wheat product will be needed for our own uses, and we shall cease to be an exporter of grain. There is still some room in Canada, but it will soon be filled. The relief will be but temporary. Our own people, whose mineral resources will by that time have greatly diminished, must find themselves thrown back upon the soil for a living. If continued abuse of the land should mark the next 50 years as it has the last, what must be our outlook?

Even the unintelligent are now coming to understand that we cannot look to our foreign trade for relief from future embarrassment. Our total exports, about one-fourth in value of the products of our farms, consist to the extent of more than 70% of articles grown on the soil or directly sustained by it, such as live-stock, or made from soil products, such as flour. Of all the materials used in manufacture in this country, 42% are furnished by the soil. We shall have less and less of this agricultural wealth to part with as population increases. And as to enlarging greatly our sale of manufactured products in the world's markets, it is mostly a dream. We cannot finally compete there, except in a few selected lines, without a material lowering of the wage scale at home and a change in the national standard of living which our people are not ready to accept without a struggle. When capital cannot find a profit there will be no money for the payrolls of an unprofitable business. Doubtless as we grow we shall buy more and sell more; but our main dependence half a century ahead must be upon ourselves. The nation can no more escape the operation of that law than can the man. It is time to set our house in order.

Not only the economic but the political future is involved. No people ever felt the want of work or the pinch of poverty for a long time without reaching out violent hands against their political institutions, believing that they might find in a change some relief from their distress. Although there have been moments of such restlessness in our country, the trial has never been so severe or so prolonged as to put us to the test. It is interesting that one of the ablest men in England during the last century, a historian of high merit, a statesman who saw active service and a profound student of men and things, put on record his prophecy of such a future ordeal. Writing to an American correspondent 50 years ago, Lord Macauley used these words:

> As long as you have a boundless extent of fertile and unoccupied land your laboring population will be found more at ease than the laboring population of the Old World; but the time will come when wages will be as low and will fluctuate as much with you as they do with us. Then your institutions will be brought to the test. Distress everywhere makes the laborer mutinous and discontented and inclines him to listen with eagerness to agitators who tell him that it is a monstrous iniquity that one man should have a million and another cannot get a full meal. . . . The day will come when the multitudes of people, none of whom has had more than half a breakfast or expects to have more than half a dinner, will choose a legislature. Is it possible to doubt what sort of legislature will be chosen? . . . There will be, I fear, spoliation. The spoliation will increase the distress; the distress will produce fresh spoliation. . . . Either civilization or liberty will perish. Either some Caesar or Napoleon will seize the reins of government with a strong hand, or your Republic will be as fearfully plundered and laid waste by barbarians in the twentieth century as the Roman Empire in the fifth.

We need not accept this gloomy picture too literally, but we have been already sufficiently warned to prevent us from dismissing the subject as unworthy of attention. Every nation finds its hour of peril when there is no longer free access to the land, or when the land will no longer support the people. Disturbances within are more to be feared than attacks from without. Our government is built upon the assumption of a fairly contented people, ruling their passions, with power to change their institutions when such change is generally desired. It would not be strange if they should in their desire for change attempt to pull down the pillars of their national temple.

Far may this day be from us. But since the unnecessary destruction of our land will bring new conditions of danger, its conservation, its improvement to the highest point of productivity promised by scientific intelligence and practical experiment, appears to be a first command of any political economy worthy of the name.

I have endeavored to outline some of the principal issues at stake in the better conservation of our national resources, and especially that one about which all the others revolve and by whose fortunes we shall eventually stand or fall—the land itself. They are for us quite literally the issues of national existence. The era of unlimited expansion on every side, of having but to reach out and seize any desired good, ready provided for us by the hand that laid the foundations of the earth, is drawing to a close.

The first task, it seems to me, must be to force home the facts of the situation into the public consciousness; to make men realize their duty toward coming generations exactly as the father feels it a duty to see that his children do not suffer want.

In a democracy this is a first essential. In other forms of government one or two great men may have power to correct mistakes and to put in motion wise policies that centuries do not unsettle. A part of the price of self-government is the acceptance of that high office and imperative duty as a whole by the people themselves. They must know, they must weigh, they must act. Only as they form and give effect to wise decisions can the nation go forward.

And we should not be here to-day were it not that the principle of a conservation of national resources as the foremost and controlling policy of the United States henceforth is coming to be seen by many, and must be heartily accepted by all, as the first condition not only of continued material prosperity, but also of the perpetuation of free institutions and a government by the people.

If this patriotic gospel is to make headway, it must be by just such organized missionary work as is to-day begun. It cannot go on and conquer if imposed from without. It must come to represent the fixed idea of the people's mind, their determination and their hope. It cannot be incorporated in our practical life by the dictum of any individual or any officer of Nation or State in his official capacity. It needs the cooperation of all the influences, the help of every voice, the commendation of Nation and State that has been the strength and inspiration of every worthy work on American soil for 120 years.

We return, for our gathering in council and for our plan of action for the future, to the model given us by the Fathers. State and Nation are represented here, without jealousy or any ambition of superiority on either side, to apply to the consideration of our future such cooperation as that out of which this Nation was born and by which it has won to worthy manhood.

Reviving the spirit of the days that created our Constitution, the days that carried us through civil conflict, the spirit by which all our enduring work in the world has been wrought, taking thought as Washington and Lincoln took thought, only for the highest good of all the people, we may, as a result of the deliberations held and the conclusions reached here to-day, give new meaning to our future; new luster to the ideal of a Republic of living federated states; shape anew the fortunes of this country, and enlarge the borders of hope for all mankind.

Mr. Hill's address was followed by a paper by Dr. T. C. Chamberlain, President of the American Association for the Advancement of Science and head of the Department of Geology of the University of Chicago. His paper entitled "Soil Wastage," made clear that wastage of the soil—that thin covering of the earth's surface only a few inches to a few feet in thickness, which supports the whole vegetable and animal life of the earth, is a serious menace. We quote:

> Surface wastage is a serious menace to the retention of our soils under present modes of management. Historical evidence enforces this danger. In the Orient there are large tracts almost absolutely bare of soil on which stand ruins which imply former flourishing populations. Other long-tilled lands bear similar testimony.
>
> It must be noted that more than loss of fertility is here menaced. It is the loss of the soil-body itself, a loss almost beyond repair. When our soils are gone, we too must go, unless we shall find some way to feed on raw rock or its equivalent. The immense tonnage of soil-material carried out to sea annually by our rivers, even when allowance is made for laudable wash, and for material derived from the river channels, is an impressive warning of the danger of negligent practices. Nor is this all; the wash from one acre is often made the waste-cover for another acre, or for several.

Dr. Chamberlain pointed out the importance of developing our resources in the way of crop yielding plants, so that suitable soil-holding plants might be developed for covering steep slopes where the surface wash causes the worst erosion. The necessity of retaining the forest cover on steep mountain slopes to prevent erosion is also evident. In conclusion, he said:

> If the loss of soils proceeds at the present rate and the number of inhabitants continues to increase as now, the value of the residue of tillable land which will remain after a few centuries will so appreciate as to force extreme measures for its conservation. The pitiable struggles of certain Oriental peoples to retain and cultivate the scant remnant of once ample soils is at once an example and a warning. Our escape from this dire struggle should spring from a clearer forevision, a deeper insight, greater technical skill, and indefatigable industry.

Mr. R. A. Long, late President of the Southern Pine Manufacturers' Association, followed with a paper on "Forest Conservation," in which he further alluded to the warning given by the soil-denuded lands of the Orient as the result of general forest destruction. Mr. Long estimates that within 13 years we will have exhausted our remaining stock of Southern yellow pine, and the supply of white and Norway pine in the States bordering on the Great Lakes will be exhausted even before that time. Mr. Long's suggestions for a remedy were as follows:

> First. The Government could, by a contractual relation with the owners of the forests where lumbering operations are now being carried on (who constitute at least 80% of the timber holdings of the United States) provide that conservation and reforestation should be practiced under rules prescribed by the Forest Service, and assess the cost thereof against the timber lands proportionately. These rules should provide that the lumbering operations, so far as conservation and reforestation were concerned, should be conducted under governmental control; that no more timber should be cut than was necessary to supply the current demands, thus maintaining such uniformity of prices as would justify the operator to utilize every log the tree would produce; that only trees of a certain size should be cut; that seed trees, properly distributed, should be left; that the young growth should be protected from fires and other elements of destruction, and it would seem clear that the establishment of such a relationship would certainly accomplish this highly desired object.
>
> Second. A plan might be worked out jointly between the owners of the timber lands, and the Government, by which conservation and reforestation would be practiced along such lines as the Government might lay down, as outlined above, and the timber owners be protected in the prices of all lands cut over and handled under the conditions prescribed.
>
> Whatever plan is adopted must furnish an incentive, a substantial inducement to the timber owner, to forego a present gain for the public good, and in this matter it can only be accomplished by governmental cooperation. And what is done should be done quickly, for the time is fast approaching when our forests will be so nearly gone that it will be too late.
>
> Will the Government avail itself of this golden opportunity to lend its aid to the conservation of this splendid natural resource, in order to supply the timber for future generations; be wise and patriotic enough to provide for the inevitable result that must occur before the middle of the twentieth century, and thereby perform the true function of all good governments in the promotion of the health, wealth, and prosperity of the people? Or, with climatic changes following the destruction of our forests, shall manufacture die with them, and commerce fail as a natural result of agricultural and manufacturing decadence?

The general discussion on the subject was opened by Secretary Wilson, of the Department of Agriculture, who pointed out that the rapid exhaustion of farming lands was largely due to ignorance and bad management by the farming population. He alluded to the work of the Department in finding and introducing new crops suitable for the "dry farming" methods in the semi-arid West, and stated that 50 million bushels of the new wheat which the Department introduced for dry farming were raised last year. Concerning the exhaustion of soils in the Eastern States through the washing out of their fertile elements by excessive rainfall, the Secretary declared that the irrigated lands of the far West may yet be the reliance for feeding the cities of the East.

Mr. J. S. Whipple, the New York Forest Commissioner, told of the rapidly approaching exhaustion of New York's timber resources, but said that the State was planting more trees than the Federal forestry department itself. Other speakers were Gov. Fort of New Jersey, who told of New Jersey's work in forestry; President

Hadley, of Yale University, who described the work of the Yale Forestry School, and Gov. Glenn of North Carolina, who in an impassioned address appealed for the establishment of the Federal forest reserve in the Southern Appalachians. "North Carolina," said Gov. Glenn, "sorely needs the preservation of her steep mountain slopes from erosion, yet much of the work of forest preservation needed to be done in North Carolina will be chiefly for the benefit of other States. The States themselves are practically powerless to carry out the necessary measures for protection. I have been in Washington eight different times," continued Gov. Glenn, "beseeching at the doors of Congress for the creation of the Federal forest reserve in our Southern mountains. Each time I have been told 'next session,' 'next session.' Gentlemen: When will the next session come?"

At a dinner on the previous evening Speaker Cannon had opposed the use of Federal powers for the protection of forests and other natural resources and had advised that the States ought to form Confederation compacts among themselves to carry out works in which they were jointly interested. Gov. Glenn, who is an old Confederate soldier, alluded to this advice of Speaker Cannon and said, "I can tell Speaker Cannon that we tried Confederation once and it didn't pay."

Other speakers were Mr. Wills, Secretary of the American Forestry Association, and Gov. Davidson of Wisconsin.

IRRIGATION AND GRAZING.

At the session on Thursday afternoon the first speaker was ex-Gov. Pardee of California. His paper was an admirable presentation of the situation in California with respect to forest protection, irrigation and the tendency to concentrate the water-power of the State in the control of great monopolies. He paid a high tribute to the work done by the Federal forest service in protecting from destruction the forests on the high mountain slopes, so necessary to the irrigated farms in the valleys below. He appealed for still further extensions of the forest reserves. Gov. Pardee is a man of commanding personality and a finished public speaker. His address made a strong impression.

A paper by Hon. J. A. Jastro, President of the National Live Stock Association, followed. The paper was devoted to range conditions in the Southwest; and he set forth the urgent necessity for Federal control of the Government grazing lands to prevent the overstocking of the range, the cattle wars and the destruction of all vegetation, which is fast taking place. We quote as follows:

Within the arid and semi-arid regions there are about 135 million acres of public lands, upon the proper use, protection and development of which, depends much of the future prosperity and growth of the Southwest. This vast range, with one exception, is fast being destroyed by unwise and indiscriminate use and abuse. The one exception is the lands which have been withdrawn for purposes of forest protection and which, under a wise and efficient system of management, and especially as to its use by the stockmen, is rapidly and almost miraculously in many instances, recovering its former splendid condition.

The manner in which these forest lands have been handled, the methods by which, while still furnishing almost its full amount of grazing they yet have been reseeded and are again assuming their old-time conditions, points out in a most convincing and almost unanswerable way the course to proceed if the balance of these lands are to be saved and made a source of value to the people and the country in general.

Under some plan of government control these lands can be managed so as to secure to the users, the stockmen and settlers, a permanency in their business which they do not now, nor can they ever, enjoy under our present land laws.

Residing in Kern County, in the State of California, where the entire flowage of Kern River is applied to agricultural lands on what is known as the Kern River Delta, to a large extent under my personal supervision, I can state as a fact that a very perceptible effect is observed upon the low water flow of the river since the exclusion of sheep from the forest reserves, covering the river's watershed.

It is not claimed that the aggregate discharge of a river is increased by the growth of timber or vegetation, but it is demonstrated that the run-off is more gradual and is prolonged through a greater length of time. That is to say, the forests and vegetation serve the same purpose as artificial reservoirs made by dams, or otherwise. Also it is evident that if the ground surface is protected by timber or vegetation from erosion, artificial reservoirs are protected from being quickly filled up by detritus from the mountain slopes, and disastrous torrents are prevented.

According to daily measurements of Kern River, during the period of seven years, from 1899 to 1906, we find an increase of the minimum flow, which in 1899 was 86.22 to 222.06 ft. in 1906,—an increase of 50% for the 7th year.

through this steady and gradual increase, the area of lands put under a system of irrigation was increased from 130,000 acres in 1899, to over 180,000 acres in 1906.

Also, according to the statement of Elwood Mead, in his report of Irrigation Investigation in California, in 1901, there seems to be a very conclusive demonstration of the effect of forests on the watershed of a river on the low water run-off. A case in point is the difference between the run-off of the two branches of the North Yuba River. The North Fork, being heavily timbered, furnishes 75% of the low water flow, which is supplied from only 1/10 of the total drainage area—the watershed of the South Fork being comparatively bare of timber. Mr. Mead summarizes his conclusions on this subject in the following language:

It appears that the solution of the problem of a storage of flood waters is not in the retention of a small percentage of the storm waters behind dams, but in applying storage over the entire water-shed by the systematic extension of forest and brush covered areas.

Ex-Senator Carey of Wyoming opened the discussion and was followed by Gov. Brooks of Wyoming, Gov. Cutler of Utah, Gov. Gooding of Idaho and Gov. Norris of Montana. All the speakers were earnest in commendation of the Forest Reserves as a necessary factor in conserving the water supply for irrigation; but one or two of the Governors protested against the charging of fees for timber cut from the Federal forests, or for the use of the land for grazing purposes or for the use of the water power of streams rising in the forest reserves.

In reply to these criticisms, Secretary Garfield, in a forcible address which won the enthusiastic approval of the conference, declared that as the forest preserves were the property of the whole people, it was only fair and equitable that the private interests which wanted to use this property should pay for such use. He made it clear that the Department of the Interior, in carrying out its policies, was actually working to protect the public interests against the opposition of the few who desired to make use of public property for their own private enrichment.

CLOSING SESSION: FRIDAY MORNING.

The planned program for the conference provided for two sessions on Friday, one in the morning, when papers on the Public Health, by Dr. Geo. M. Kober, Navigation on American Waterways, by Prof. Emory R. Johnson, and Water Power, by H. S. Putnam, were scheduled for presentation, and the other session in the afternoon for closing business and general discussion.

It was deemed best, however, to take up the general business at the opening of the morning session and after its dispatch to afford an opportunity for those governors attending the conference who had not already taken part in the discussion to express themselves regarding the subjects for which the meeting was held. The papers not presented will be printed in the proceedings.

President Roosevelt was in the chair throughout the session and called first for the report of the committee on resolutions, which was presented by the Chairman, Gov. Blanchard, of Louisiana. Many resolutions had been handed to the Committee taking up special subjects, but the Committee, he said, had deemed it wise to confine the formal resolutions to those broad general matters relative to the purposes of the conference in which all the delegates could join without possibility of dissent. The resolutions, which were adopted by the conference by unanimous vote, are as follows:

"We, the Governors of the States and territories of the United States of America, in conference assembled, do hereby declare the conviction that the great prosperity of our country rests upon the abundant resources of the land chosen by our forefathers for their homes, and where they laid the foundation of this great nation.

"We look upon these resources as a heritage to be made use of in establishing and promoting the comfort, prosperity and happiness of the American people, but not to be wasted, deteriorated nor needlessly destroyed.

"We agree that our country's future is involved in this; that the great natural resources supply the material basis upon which our civilization must continue to depend, and upon which the perpetuity of the nation itself rests.

"We agree, in the light of facts brought to our knowledge and from information received from sources which we cannot doubt, that this material basis is threatened with exhaustion. Even as each succeeding generation from the birth of the nation has performed its part in promoting the progress and development of the Republic, so do we in this generation recognize it as a high duty to perform our part, and this duty in large degree is the adoption of measures for the conservation of the natural wealth of the country.

"We declare our firm conviction that this conservation of our natural resources is a subject of transcendent importance, which should engage unremittingly the attention of the nation, the States and the people in earnest cooperation. These natural resources include the land on which we live and which yields our food! the living waters which fertilize the soil, supply power and form great avenues of commerce; the forests which yield the materials for our homes, prevent erosion of the soil and conserve the navigation and other uses of our streams, and the minerals which form the basis of our industrial life and supply us with heat, light and power.

"We agree that the land should be so used that erosion and soil wash should cease; that there should be reclamation of arid and semi-arid regions by means of irrigation and of swamp and overflowed regions by means of drainage; that the waters should be so conserved and used as to promote navigation, to enable the arid regions to be reclaimed by irrigation, and to develop power in the interests of the people; that the forests, which regulate our rivers, support our industries and promote the fertility and productiveness of the soil, should be preserved and perpetuated; that the minerals found so abundantly beneath the surface should be so used as to prolong their utility; that the beauty, healthfulness and habitability of our country should be preserved and increased; that the sources of national wealth exist for the benefit of all the people, and that the monopoly thereof should not be tolerated.

"We commend the wise forethought of the President in sounding the note of warning as to the waste and exhaustion of the natural resources of the country, and signify our high appreciation of his action in calling this conference to consider the same and to seek remedies therefor through cooperation of the nation and the States.

"We agree that this cooperation should find expression in suitable action by the Congress within the limits of, and co-extensive with, the national jurisdiction of the subject, and complementary thereto, by the legislatures of the several States within the limits of, and co-extensive with, their jurisdiction.

"We declare the conviction that in the use of the natural resources our independent States are interdependent and bound together by ties of mutual benefits, responsibilities and duties.

"We agree in the wisdom of future conferences between the President, members of Congress and the Governors of the States regarding the conservation of our natural resources, with the view of continued cooperation and action on the lines suggested. And to this end we advise that from time to time, as in his judgment may seem wise, the President call the Governors of the States, members of Congress and others into conference.

"We agree that further action is advisable to

ascertain the present condition of our natural resources and to promote the conservation of the same. And to that end we recommend the appointment by each State of a commission on the conservation of natural resources, to co-operate with each other and with any similar commission on behalf of the Federal Government.

"We urge the continuation and extension of forest policies adapted to secure the husbanding and renewal of our diminishing timber supply, the prevention of soil erosion, the protection of headwaters and the maintenance of the purity and navigability of our streams. We recognize that the private ownership of forest lands entails responsibilities in the interests of all the people, and we favor the enactment of laws looking to the protection and replacement of privately owned forests.

"We recognize in our waters a most valuable asset of the people of the United States, and we recommend the enactment of laws looking to the conservation of water resources for irrigation, water supply, power and navigation, to the end that navigable and source streams may be brought under complete control and fully utilized for every purpose. We especially urge on the Federal Congress the immediate adoption of a wise, active and thorough waterway policy, providing for the prompt improvement of our streams and conservation of their watersheds required for the uses of commerce and the protection of the interests of our people.

"We recommend the enactment of laws looking to the prevention of waste in the mining and extraction of coal, oil, gas and other minerals with a view to their wise conservation for the use of the people and to the protection of human life in the mines.

"Let us conserve the foundations of our prosperity."

In the discussion during the sessions there had been frequent reference to the conflict between State and Federal jurisdictions. President Roosevelt, during the closing session, took occasion to express his views on this subject in a vigorous statement as follows:

Gentlemen: Just a word on what has been called the "Twilight Land" between the powers of the Federal and State governments.

My primary aim in the legislation that I have advocated for the regulation of the great corporations has been to provide some effective popular sovereign for each corporation. I do not wish to keep this twilight land one of large and vague boundaries, by judicial decision that in a given case the State cannot act, and then a few years later by other decisions that in practically similar cases the nation cannot act either. I am trying to find out where one or the other *can* act, so there shall always be some sovereign power that, on behalf of the people, can hold every big corporation, every big individual, to an accountability so that its or his acts shall be beneficial to the people as a whole.

In matters that relate only to the people within the State, of course, the State is to be sovereign, and it should have the power to act. If the matter is such that the State itself cannot act, then I wish, on behalf of all the States, that the National Government should act.

Take such a matter as charging a rent for water power. My position is simply that where a privilege, which may be of untold value in the future to the individual grantee, is asked from the Federal government, then the Federal government should put into the grant a condition that it shall not be a grant in perpetuity.

If there is necessity for the grant, then there must be power to attach conditions to the grant. Make it long enough so that the corporation shall have an ample material reward. The corporation deserves it. Give an ample reward to the captain of industry; but not an indeterminate and infinite reward.

Put in a provision that will enable the next generation—that will enable our children, at the end of a certain specified period, to say what, in their judgment, should then be done with that great natural power which is of use to the grantee only because the people as a whole allow him to use it.

It is eminently right that he should be allowed to make ample profit from his development of it, but make him pay something for the privilege, and make the grant for a fixed period, so that when the conditions change, as in all probability they will change, our children—the nation of the future—shall have the right to determine the condition upon which that privilege shall be enjoyed.

In these cases the State has not acted or cannot act; therefore, I hold the nation should act. Where the policy I advocate can be carried out best by the State, let it be carried out by the State; where it can be carried out best by the nation, let it be carried out by the nation.

My concern is not with the academic side of the question; I deal with the matter practically from the standpoint of true popular interest; and, therefore, my desire is to employ indifferently either the principle of States' rights or the principle of national sovereignty, whichever, in a given case, will best conserve the needs of the people as a whole.

Hon. Wm. J. Bryan, who was one of the five distinguished citizens invited by the President to attend the conference (the others being Grover Cleveland, Jas. J. Hill, Andrew Carnegie and John Mitchell), was invited to address the conference on the first day, but preferred to postpone his remarks until the close. On Friday morning President Roosevelt called Mr. Bryan to the platform. The spectacle of Mr. Bryan standing beside the President in the White House as his guest, delivering an address to an assemblage representing all sections and parties, was a most impressive illustration of the elimination of partisan politics in the consideration of topics beside which all matters over which present day parties clash are trivial indeed. Mr. Bryan said:

I am a strict constructionist, if that means to believe that the Federal government is one of delegated powers and that constitutional limitations should be carefully observed.

There is no twilight zone between the nation and the State in which exploiting interests can take refuge from both, and my observation is that most—not all, but most—of the contentions over the line between nation and State are traceable to predatory corporations which are trying to shield themselves from deserved punishment or endeavoring to prevent needed restraining legislation. The first point which I desire to make is that earnest men, with an unselfish purpose and concerned only for the public good, will be able to agree upon legislation which will not only preserve for the future the inheritance which we have received from a bountiful Providence, but preserve it in such a way as to avoid the dangers of centralization.

I begin with the proposition that it should be our purpose, not only to preserve the nation's resources for future generations by reducing waste to a minimum, but that we should see to it that a few of the people do not monopolize that which is in equity the property of all the people. The earth belongs to each generation, and it is as criminal to fetter future generations with perpetual franchises, making the multitude servants to a favored faction of the population, as it would be to unnecessarily impair the common store. I am glad that Secretary Garfield emphasized this point. It is one that must always be kept in mind by the nation and by the several States.

The first national asset is to be found in the life of the people, and Mr. Mitchell very properly and with great force pointed out the importance of safeguarding the life, the limbs, and the health of those who are engaged in converting the nation's natural resources into material wealth. I would go a step farther and say that we could well afford to include in the appropriations made by Congress a sum sufficient to carry on necessary investigations into the causes of diseases national in their scope, and to stimulate the search for remedies which would add to the life, health, and usefulness of the whole population.

I was surprised at the statistics given in regard to our coal and our iron ore. While it is possible that new coal measures and new ore beds may be discovered, we cannot afford to base our conduct upon speculations as to what may yet be discovered. We should begin an intelligent supervision and conservation of that which is known to exist, and I respectfully submit that it is worth while to ask ourselves whether we can afford to offer a bounty to those who are engaged in exhausting the supply of raw materials, which, when gone, cannot be replaced. Surely if there is any importation which we can properly encourage by a free list, it is the importation of those raw materials of which our own supply is limited. And what I say in regard to coal and iron ore is equally applicable to timber. It is hardly consistent to discourage the importation of lumber, while we worry about the devastation of our forests.

Mr. Hill has rendered the conference a real service in presenting the facts and statistics set forth in his address on land and its cultivation. Few of us, probably, were conscious of the impairment of the crop value of our soil. I am sure that a clear understanding of this subject will lead to a further enlargement of the work of the Department of Agriculture and the still closer co-operation between the Department of Agriculture and the States in teaching economical methods of agriculture. Already the rapid growth of the agricultural college offers encouragement, and I am glad to express my appreciation of the valuable work done by Secretary Wilson and his associates in bringing to our country fruits, plants, and grasses suited to the different parts of our country.

As the farmer pays more than his share of the taxes and receives less than his share of the direct benefits which flow from national appropriations, it is only justice to him that we shall be liberal in the support of every effort put forth for the improvement of agriculture. Irrigation has justified the arguments which led to the inauguration of the work. No one who has witnessed the transformation of the desert into field and garden can doubt the wisdom of the steps that have been taken. Here, as elsewhere, both the nation and the State can find a field of legitimate activity, and I am sure that there will be a continuation of this work until all of the waters which can be utilized for that purpose have been appropriated.

The same principle which was invoked in support of irrigation can be invoked in support of drainage. The question is not whether the water should be brought upon the land or taken off the land; it is whether the land shall be made tillable and its wealth-producing qualities utilized. Drainage of the swamps is, therefore, as legitimate a work as the reclamation of arid wastes.

No subject has been brought out more prominently at this conference than the subject of forestry, and it justified the time devoted to it, for our timber lands touch our national interests at several points. Our use of lumber is enormous, but immense as would be the inconvenience and loss caused by the absence of lumber, the consequence of the destruction of our forests would be still more disastrous to the nation. As has been shown, the timber on our mountain ranges protects our water supply. Not to speak of changes in climate which might follow the denuding of our mountains, the loss to the irrigated country could not be remedied and the damage to the streams could not be calculated. And if this is not enough to arouse the interest of all, I may add that the destruction of the forests on the mountain ranges would in time impair the underflow upon which we rely for our well water.

The good effects of this conference are already apparent in the determination expressed by several governors to at once appoint forestry commissions and begin such work as the State can do. In this case action is so urgent and the field to be covered so large that both the nation and the several States can exert themselves to the full without danger of going too far. The national reservations already made in the West and the new reservations that ought to be made, and are likely to be made, in the White Mountains and in the Appalachian range can doubtless be so administered as to protect national interests without unduly burdening the States in which the reservations are located or needlessly interfering with the development of the States. No national policy need retard the development of the Western States, and their own interests would restrain them from sacrificing future wealth and protection for temporary advantage.

Lastly, I come to our interior waterways. I shall not defend the improvement of these waterways on the ground that such improvement would help to regulate the railroad rates, although it would aid regulation, whenever the people are ready to exercise the power which they have. But water traffic is less expensive than traffic by rail, and there are many commodities which can be transported much more cheaply by water than they possibly could be carried on land. I believe it has been estimated that an expenditure of $500,000,000 on inferior waterways would result in a saving of nearly $200,000,000 annually.

If this saving were equally divided between the producers and the consumers it would be an enormous profit to both, and Mr. Carnegie has pointed out that water transportation, by requiring less iron and less coal, in proportion to the freight carried, would enable us to postpone the exhaustion of our iron mines and our coal beds.

The development of water transportation is essentially a national project, because the water courses run by and through many States. And yet, as has been pointed out, it would be possible for the States to do a certain amount of developing along this line if they were permitted to avail themselves of the use of the water power that could be developed.

Just a word in conclusion about an investment in permanent improvements. Money spent in care for the life and health of the people, in protecting the soil from erosion and from exhaustion, in preventing waste in the use of minerals of limited supply, in the reclamation of deserts and of swamps, and in the preservation of forests still remaining and the replanting of denuded tracts—money invested in these and in the development of waterways and in the deepening of harbors is an investment yielding an annual return. If any of these expenditures fail to bring a return at once, the money expended is like a bequest to those who come after us. And as the parent lives for his child as well as for himself, so the citizen provides for the future as well as for the present.

The remainder of the session before final adjournment was devoted to addresses by various Governors voicing their approval of the objects which the conference was called to effect.

The social events of note in connection with the conference were a dinner to the Governors and other distinguished delegates, given by the President at the White House on the evening of May 12; a dinner given the same evening by the Washington Society of Engineers in cooperation

Charles Whiteside Rae.

with the Washington members of the American Society of Civil Engineers to the Presidents of National Engineering Societies in attendance upon the conference; a dinner to the Governors given by the Washington Board of Trade on Wednesday evening; a reception to all the members of the conference given by Mr. Gifford Pinchot at his residence on Thursday evening; and a garden party by Mrs. Roosevelt to the members of the conference and ladies accompanying them on Friday afternoon.

A LARGELY INCREASED CAR SURPLUS on April 29 is reported by the Committee on Car Efficiency of the American Railway Association. The total of surplus cars on that date was 413,605, which is an increase of 37,835 cars over the preceding report, April 15, 1908. The following table gives the progress of car surplus totals since last October:

Oct. 30, 1907	3,946
Nov. 27	40,348
Dec. 24	209,310
Jan. 22, 1908	342,580
Feb. 5	343,928
Feb. 19	322,513
March 4	314,992
March 18	297,042
April 1	307,507
April 15	375,770
April 29	413,605

There are some countervailing shortages, but since last December these have been only 1,000 or less, being 267 on April 29. The increase in the surplus in the last two weeks of April was greatest in the Eastern group of railways, covering New York, New Jersey, Delaware, Maryland and eastern Pennsylvania, while on the other hand the New England group shows the greatest decrease of surplus. The increased surplus is greatest for coal cars (gondolas and hoppers), their total increasing from 160,205 to 186,742, while box cars increased from 138,065 to 147,971. In connection with these figures it is to be remembered that this part of spring is a slack season, there being practically no crop movement and a large drop in the coal movement. The present coal car surplus is the greatest in the period covered by the above table, while the box car surplus is still a little below the figure reached on Jan. 8, 1908.

CHARLES WHITESIDE RAE.

Rear-Admiral Charles Whiteside Rae, Engineer-in-Chief of the United States Navy, Chief of the Bureau of Steam Engineering, Navy Department, died at his home in Washington, D. C., on the evening of May 14, from complications following an acute attack of rheumatism.

Rear-Admiral Rae was born at Hartford, Conn., June 30, 1847. His early education was received at the Champlain Academy, Champlain, N. Y.; he graduated from Rensselaer Polytechnic Institute with the class of 1866, and from the Naval Academy in 1868. In 1906 he received the degree of D. Sc. from the University of Pennsylvania. In 1900 he married Miss Rebecca Gilman Dodge, of Washington, who alone survives him. He became an acting assistant engineer in the volunteer navy on Oct. 10, 1866, and after graduating from the Naval Academy was promoted through the regular engineer grades, becoming a captain on Jan. 3, 1903. About 14 years of this service was at sea in various parts of the world. During this period he was in charge of the work of establishing a line of levels across the Isthmus of Tehuantepec (1870) and shortly after that was attached to the Nicaragua Canal Survey Expedition. From 1893 to 1897 he was a member of the instructing staff of the Naval Academy. During the Spanish-American War he was Chief Engineer of the battleship "Iowa" and participated in the bombardment of San Juan, Porto Rico, in the battle of Santiago and in several minor actions off the coast of Cuba. For "eminent and conspicuous conduct" during the battle of Santiago he was advanced three numbers and for distinguished service in the Cuban campaign he was awarded a medal of honor.

On August 9, 1903, President Roosevelt appointed him Engineer-in-Chief, U. S. N., with the rank of rear admiral, and Chief of the Bureau of Steam Engineering of the Navy Department, which positions he filled up to the time of his death.

Rear-Admiral Rae was a Vice-President of the Society of Naval Architects and Marine Engineers, a Past President of the American Society of Naval Engineers, a Past President of the Washington Society of Engineers, a member of the National Geographic Society, and a member of several prominent clubs in New York City and Washington.

WALTER G. BERG.

Walter Gilman Berg, M. Am. Soc. C. E., Chief Engineer of the Lehigh Valley R. R., whose demise on May 12 we briefly mentioned in our last issue, was an engineer who to the highest constructive ability united an analytical mind capable not only of solving difficult technical problems but of placing the results in a form which the layman, director or subordinate could understand and use to their full value. Born Jan. 12, 1858, in New York City, he went to Germany for professional training, winning the degree of Civil Engineer at the Royal Polytechnic Institute at Stuttgart in 1878, and a gold medal for a monograph on Spherical Conic Sections, in which latter competition no other American has ever been successful.

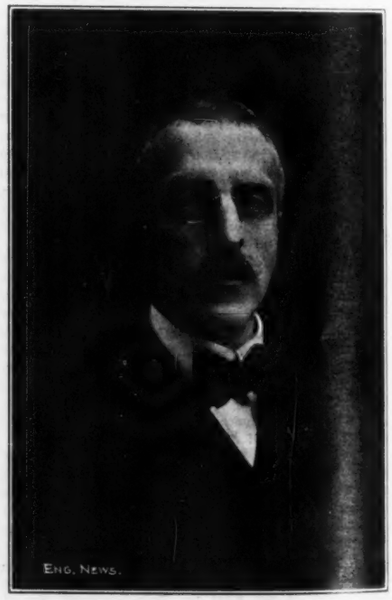
Mr. Berg's practical experience was begun as shop inspector with the Delaware Bridge Co. at New York City. He left at the end of a year to join the engineering forces of the Richmond & Allegheny Ry. (now incorporated with the Chesapeake & Ohio) and later of the East Tennessee, Virginia & Georgia Ry., now part of the Southern Ry. system.

Beginning service with the Lehigh Valley R. R. in 1883 as Assistant Engineer, he took charge of the designing and erection of various structures along the Lehigh Division, such as roundhouses and creosoting plant.

Appointed Principal Assistant Engineer in 1887, he inaugurated his activities in this position of enlarged responsibility by the construction of the transfer bridges and dock buildings of the Jersey City terminal of the road. The design of the piers in this instance, as also that of the circular freight yard, built later for the Harlem Transfer Co., are among the many examples of his originality. In 1900 he was appointed Chief Engineer of the road. His studies for the harbor improvements at Buffalo, N. Y., which as yet only partially carried out, have evolved a solution of difficult problems and much needed changes at that port. The large reservoir system in connection with the railway shops at Sayre, Pa., all designed by him, are another tribute to his constructive ingenuity. Mr. Berg was at the time of his death a member of the American Society of Civil Engineers and President of the American Railway Engineering and Maintenance-of-Way Association. He was also a Past President of the Association of Railway Superintendents of Bridges and Buildings. Works on "Buildings and Structures of American Railroads," "Strength of Timber," "American Railway Shop Systems" and "American Railway Bridges and Buildings" are due to his authorship. He leaves two young children in the care of a sister and two brothers. One of the latter, Mr. Louis de Coppet Berg, is a well-known architect. Walter Gilman Berg married in 1893 Miss Ruby Burke, of Burkesville, Va., and it is there, beside his wife who died several years ago, that he was buried.

THE BASE OF AWARD OF THE EDISON MEDAL, to such qualified student as should have submitted to the American Institute of Electrical Engineers the best thesis on research in theoretical or applied electricity or magnetism, has been changed so that it is no longer open to competition but is to be awarded for meritorious achievement in electrical engineering to a resident of the United States or dependencies or of Canada. It will be recalled that this gold medal award was founded in 1904 through the Edison Medal Association, made up largely of friends and associates of Thomas A. Edison. No student has entered in competition for the medal since it was established and it has been decided that the foundation has become a dead letter and that the conditions of award did not meet existing circumstances.

A BUREAU OF WATER-POWER UTILIZATION has been added to the Department of the Interior of the Kingdom of Bavaria. The chief functions of the bureau will be (1) to develop plans for state water-power plants and to survey water-powers in order to determine their



Walter G. Berg

desirability for state purposes; (2) to advise private parties concerning the commercial utilization of water-powers; and (3) to examine and approve plans for the water-power developments. The development of water-powers by the state will have in view among other things the supply of current for electric operation of railways.

ANNUAL CONVENTION OF THE AMERICAN WATER WORKS ASSOCIATION.

The 27th annual convention of the American Water Works Association was held at Washington, May 11 to 16, occupying practically the entire week. There was a large attendance. Every one seemed to be strongly of the opinion that it was the most successful convention in the history of the association. Besides a very large number of papers, there were numerous interesting excursions and other entertainments provided for the members and guests, but all so skilfully arranged as to interfere scarcely at all with the business of the convention. In fact, it would have been very wearisome to have transacted so much business as was done had there not been a considerable amount of entertainment by way of relief.

The exhibit by the associate members was large and representative, and was so placed in relation to the convention hall that every person who entered the latter was forced to see a large proportion of the exhibits.

The meeting opened on Monday evening with a reception, at which a welcome was extended by Mr. Henry B. F. McFarland, President of the Commissioners of the District of Columbia. An interesting address was made on this occasion by Senator Newlands, of Nevada. Mr. George H. Felix, President of the association, responded. These addresses were followed by a largely attended ball.

On both Tuesday and Thursday three sessions were held, at which a large number of papers were presented. On Wednesday there was but a single business session, in order to give opportunity for an excursion by boat to and beyond Mt. Vernon. Two business sessions were scheduled for Saturday, but the rainy afternoon on Friday placed at the disposal of the convention the time reserved for observing a United States Artillery Drill at Fort Meyer and a trip to the National Cemetery at Arlington. Accordingly the papers scheduled for Saturday were disposed of, leaving that day available for a visit to the Washington filtration plant.

THE PRESIDENT'S ADDRESS.—President Felix presented a suggestive address. He dealt almost wholly with possible ways and means of increasing the usefulness of the association. He spoke of the lack of time for full and free discussion of the many papers presented at the convention. Discussions on some of these papers and on other important matters with which the association should deal is sometimes delayed a year on account of the fact that only annual meetings are held. Some plan should be adopted by which more extended discussions could be ensured and all matters of interest and importance be brought before the members with greater promptness.

Among improvements in the organization and methods of the association, Mr. Felix suggested permanent headquarters, including a bureau of water statistics in charge of a secretary under the supervision of a small but strong executive committee. Stress was laid upon the desirability of having a well-paid permanent secretary who should devote his whole time to the work, but it was clear to all present that by such remarks no reflections of any sort were intended to be cast upon the present secretary, who, every one seems to feel, is devoting more time and energy to his work than could reasonably be expected. The subject of securing funds to carry on enlarged work was touched upon during the address, but no more definite suggestions were made than the possibility of securing money by subscription.

A committee on the president's address was appointed, in the hope that the general recommendations made by Mr. Felix might be crystallized into some plan for definite action. The committee of seven appointed for this purpose, however, felt that it was impossible within the brief period at its disposal to report anything in detail, and therefore suggested that another one be appointed to consider the subject through the year.

OTHER REPORTS.—Secretary Diven reported a total membership at the beginning of the convention of 822, including 131 members just elected. This number was added to during the convention, making the net gain in membership for the year over 100. The loss in membership had included 16 resignations, 7 deaths and 9 members whose names have been dropped, or a total of 32.

The treasurer's report showed a cash balance of $62, as compared with $218 at the last convention, but as only 11 months had intervened this loss was more apparent than real. In fact, there was due the association $2,000, as compared with $800 a year ago. The Finance Committee reported that the increase in dues had made it possible to pay all bills, and had resulted in an apparent loss of members due to this cause of only four.

The committees on Fire Protection, Water-Works Investigations and Electrolysis reported "progress," but the investigating committee stated that its progress had been in the wrong direction. Mr. Dabney H. Maury reported that there had been no legal decisions relating to electrolysis, but that new suits against street railway companies had been instituted.

CAST-IRON PIPE SPECIFICATIONS AND STANDARDS.—The Committee on Water-Works Standards, through Mr. Charles A. Hague, Chairman, submitted a report embodying specifications, tabular dimensions, etc., for cast-iron pipe. This report led to somewhat lengthy discussion, most of which bore upon the desirability of again postponing the adoption of the specifications and of making still further efforts to get the New England Water Works Association and the American Society of Testing Materials to join in one standard set of specifications instead of adding a third to the two already in existence. The committee felt that it had done all that could be expected of it to the end just stated, and although most of the remarks made upon the subject were in favor of still further effort to secure one standard, yet a vote on the subject indicated that those present were strongly in favor of supporting the committee and adopting its recommendations without further delay. The report did not make clear just what efforts had been made to get the American Society of Testing Materials to join in a single standard. There was no lack of testimony regarding the negotiations between the committees of the American and the New England associations. On the one hand, Mr. Hague's report and his supporting remarks on the floor were to the effect that every reasonable effort had been made to secure the cooperation of the New England committee, but without avail. On the other hand, a lengthy communication was read from Mr. Dexter Brackett, Chairman of the pipe committee of the New England Water Works Association, in which he reviewed in detail both the manner in which his committee had attempted to meet the American committee and the differences between the New England and the American specifications. Mr. Brackett stated, in effect, that his committee had been willing to consider any clear-cut proposition for changes in its specifications that might be presented to it.

The report of Mr. Hague's committee also outlined the differences between the New England and American specifications. The reports stated that, as the specifications then stood, they included 33 paragraphs, of which 19 were taken from the New England specifications, 9 from the specifications of the American Society for Testing Materials, and 5 from the specifications of the U. S. Cast-Iron Pipe & Foundry Co. The paragraphs taken from the various specifications were cited.

At the suggestion of Mr. Wood, of R. D. Wood & Co., the specifications as submitted by the American committee were modified so as to call for a breaking limit of 2,000 lbs. instead of 1,900 lbs. in the transverse test of a bar cut from a pipe. With this amendment and the incorporation of the name of the American Water Works Association in the title, the specifications as submitted by Mr. Hague were adopted by the convention.

UNIFORM ANNUAL REPORTS AND FINANCIAL STATISTICS.—Mr. Dow R. Gwinn submitted a report for the committee on Uniform Annual Reports, in which he recommended the adoption, with slight changes, of the schedule for this purpose used for many years by the New England Water Works Association. This recommendation was adopted. The committee was continued, with authority to cooperate with the like committee of the New England Association and also with the U. S. Bureau of the Census.

Mr. L. G. Powers, Chief Statistician, U. S. Census, read a paper on Water-Works Financial Schedule, which was discussed in connection with Mr. Gwinn's report. Mr. Powers set forth some of the difficulties of water-works accounting, including such charges as depreciation. Until these difficulties are overcome comparable water-works statistics will be impossible. Census agents have reported allowances for depreciation of water-works ranging from 0.1 to 12%. In justification of some of the low allowances water-works officials have urged that in place of depreciation charges they were actually spending large sums for repairs. These and other differences in accounting practice may be permissible, if part of a well-conceived and closely-followed policy, and if the practices are clearly set forth in the accounts. Strictly, however, water rates should be made high enough to meet interest charges on the total value of the plant, and to ensure this a physical valuation of the works should be made once in ten years.

Secretary Diven, in discussing the paper, said he had seen both financial and physical schedules now in preparation under Mr. Powers' direction. To have uniform annual reports it is necessary to have uniform accounts. Only a government department can collect such statistics.

WATER METERS.—A paper embodying the results of detailed tests of water meters of the larger sizes was read by Mr. Nicholas S. Hill, Jr. The title was "Probable Errors Due to the Apparatus and Gages Used in the Commercial Tests of Meters." Trident meters, 1½ to 10 ins. in size, were tested. The errors found were not sufficiently large to throw suspicion on the reliability of large meters, but were instructive in that they showed what range of errors might be expected. The paper was accompanied by ingenious diagrams.

Mr. R. J. Thomas outlined the history of the Hersey detector meter, particularly at Lowell, Mass., where it has been carefully tested by Mr. Thomas, both experimentally and by service use for four years. The results in both cases have been satisfactory. The device as a whole is simply a combination of a sealed automatically-acting valve on a private fire service, and a meter on a by-pass. Water cannot be drawn through the fire service without there being a registry on the by-pass meter, and this indicates the time the fire service was used, and also affords a means of calculating the volume drawn. Frankly speaking, it is a device to prevent stealing water for general use through a main intended (by the water department or company) for fire service only. As such, the device has proved satisfactory.

The general subject of charging for water drawn through fire services bobbed up from time to time during the convention, and as usual brought out an almost unanimous opinion from the water-works men present that stringent measures must be taken to prevent stealing water through such services.

At another time, Mr. A. S. Tuttle presented a paper in which he described the Premier meter, which utilizes the Venturi principle in connection with an ordinary small meter on a by-pass. The theory and practice of the subject was gone into in detail. Mr. Tighe, of Lowell, recited observations of the registration of Venturi and Premier meters on parallel mains of the same size and under the same static head. Allowing for differences in the ages of the mains the registration of the two meters appeared to agree well.

Mr. Geo. E. Booker described, approvingly, the use of a battery of 2-in. meters in place of a

single meter of larger size. The author, and several who discussed the paper, were of the opinion that economy of installation, reliability and accuracy, and ease of repair, all favored the proposition.

PUMPING.—During the convention a number of papers on various phases of pumping plants were presented. Mr. F. A. Barbour described a producer gas plant, and tests thereof, at St. Stephen, N. B. Mr. J. N. Chester went into the subject of high duty and low duty pumping machinery, from the viewpoint of the operator of water-works, advancing arguments and figures for the low duty. These two papers were illustrated by lantern slides, as was a lengthy one, another evening, by Mr. Chas. A. Hague. Mr. Hague reviewed the whole history of pumping engines. Mr. Wm. Perry gave a historical and general review of Suction as Applied to Pumps, including allusions to experiences on long suction mains and with air chambers.

CLEANING WATER MAINS.—A paper on The Necessity of Laying Water Mains with the View of Future Cleaning, reviewed the need for cleaning deposits and incrustations from mains, foreign practice, the few attempts of the sort here, the advantages and costs of such work, and the saving in expense of cleaning that would be effected by providing batch boxes for introducing the devices used in cleaning pipe.

A CASE OF INCRUSTATION.—At Quincy, Ill., as was set forth by Mr. W. R. Gelston, introducing sulphate of iron and lime for coagulating purposes so the two chemicals flowed together through the piping system had led to incrustation in fairly large pipes at the rate of 1 in. (radial measurement) a year. A considerable length of pipe has been cleaned, by means of hammers and chisels. The moral is to avoid carrying the two chemicals jointly through long lines of pipe, and if they must be so carried then to arrange a convenient means of disconnecting the pipe for cleaning.

Mr. Edward Bartow presented a supplementary paper on the character and composition of the incrustant and on an unsuccessful attempt to find a practicable means of removing the material by a solvent.

ACTION OF WATER ON GALVANIZED IRON.—Observations on the galvanized coating of a cup of a new water meter were reported by Mr. W. F. Montfort. The meter was one in use at St. Louis, Mo. After it had passed 962,000 gals. of water, in less than a month, the cup "was found to contain a soft, adherent, yellowish whitish coating," which, on being scraped off, analyzed as follows: zinc oxide, 75.7%; carbon dioxide, 8.1%; ferric oxide and alumina, 4.45%; calcium oxide, trace; magnesia, trace; silica and insoluble, 11.31%; total, 100%. Only traces of the zinc coating remained, but the iron showed "no pitting or tuberculation." The author stated:

> The absence of free carbon dioxide and the presence of considerable quantities of bicarbonate and neutral carbonates may be considered as the important factors in affecting the zinc, in connection with the abundant supply of dissolved oxygen which the water carried at temperature ranging from 42 to 52° F. The questions raised by the facts presented are: (1) The danger of contamination by zinc in solution. (2) The value of the zinc coating as a protection for iron pipes.
>
> As to (1) it may be said that despite the rapid flow through the meter of almost a million gallons of water, so large a portion of the zinc compounds remained in place, that there is small chance of serious pollution from the slight quantity of basic carbonate or oxide which could dissolve. Furthermore, repeated tests of this water after exposure to zinc, and its oxide and basic carbonate for a period of an hour, show only infinitesimal traces of zinc.
>
> As to (2) the continuous action of an excess of this water through 24 days was sufficient to remove almost the entire body of zinc or to convert it into the compounds above mentioned.

WATER RATES OF 375 CITIES.—A tabulation of the water rates charged in 375 cities, together with comments on those rates and on the general subject of water rates, was submitted by Mr. Dow R. Gwinn.' The author pointed out the impossibility of establishing a single schedule of rates fair to all cities, owing to many local variations in the cost of service. He urged that interest on investment and taxes should be taken into account in formulating rates. He stated that the average water-department report does not disclose whether water is being supplied at a profit or a loss, and added that if "the actual cost of water furnished by municipalities was known, there would be a general advance in the rates charged." Where water in small quantities is filtered or is pumped twice, Mr. Gwinn was of the opinion that a rate of at least 40 cts. per 1,000 gals. should be charged. The minimum charge for water supplied for domestic purposes, if filtered or if from an artesian well and delivered through a meter, should be at least $1 a month, but the writer did not advocate setting meters on services supplying only one faucet.

The average annual meter charges in 375 cities as given by Mr. Gwinn are shown in Table I. Comments on the rates charged by private companies were made as follows:

TABLE I.—AVERAGE ANNUAL AND METER RATES CHARGED IN 375 CITIES.

	Priv.	Pub.	Bath*
Domestic use in 6-room house or 5 persons or 1st faucet	6.83	$6.04	$6.40
Additional for 1 bath, hot water connections	3.88	2.99	3.40
Additional for 1 self-closing water closet	3.69	3.12	3.38
	$14.40	$12.15	$13.18
Additional for 1 basin, hot water connection	1.94	1.55	1.74
	$16.34	$13.70	$14.92
Additional for sprinkling 50' × 140' lot, including sidewalk and street in front	6.17	4.37	5.20
Total charge per annum for all the above privileges	20.83	16.34	18.33
SCHEDULE METER RATES.			
Highest per 1,000 gallons	$0.318	$0.218	$0.262
Lowest per 1,000 gallons	0.108	0.079	0.092
Number of reports from cities with private owned plants			162
Number of reports from cities with public owned plants			213
Total number of reports received			375
(Several plants have been purchased by the municipality since the information was received.)			
Average population of cities (1900) with private owned plants			25,437
Average population of cities (1900) with public owned plants			85,382
Average population of cities (1900) all cities reporting			59,577

*Private and public.

The average charge in 134 cities supplied by private companies for a 6-room house, bath, closet, basin and 50 ft. of sprinkling is approximately $21. This is not high enough where water is furnished under difficult conditions. The writer would prefer to divide the various items a little differently than the averages indicate. The rate for a bath tub with or without hot water connections should be about 50% of the domestic rate. The water-closet rate, say 70% of the domestic rate, the stationary wash-basin rate, 15% and the sprinkling rate should be, at least, equal to the domestic rate. The average rate for domestic use in a 6-room house in 149 cities supplied by companies was found to be $6.83. Now, the writer believes that where the water is filtered, or where there is double pumping, the rate should be 25% higher than where water is furnished under ordinary conditions. Assuming that $6.00 is a fair rate for domestic use in a 6-room house where water is not filtered and is only pumped once, and that filtered water, or water that is pumped twice is worth 25% more than the unfiltered, the result would be as shown by Table II.

TABLE II.—RATES UNDER ORDINARY AND EXTRAORDINARY CONDITIONS.

	Ordinary conditions.	Double pumping or filtration.
Domestic use 6 rooms	$6.00 + 25%	$7.50
Bath, with or without hot water	3.00 + 25%	3.75
Water-closet (self-closing)	4.20 + 25%	5.25
Wash-basin	.90 + 25%	1.13
	$14.10	$17.63
Sprinkling 50-ft. lot in connection with above uses	6.00 + 25%	7.50
	$20.10	$25.13
METER RATES.		
Minimum monthly rate	.80 + 25%	1.00
Sliding Scale.		
Highest meter rate, per 1,000 gals. net	.32 + 25%	.40
Lowest meter rate, per 1,000 gals. net	.08 + 25%	.10
Special rate where consumption is 3,000,000 gals. or more per month	.065 + 25%	.081

In discussing this paper, Mr. M. N. Baker stated that the only proper basis for water rates is the cost of supplying water, and that this cannot be ascertained until reforms in accounting have been effected, and that comparisons of rates charged in different cities cannot be properly made until water-works accounting has been put on a sufficiently uniform basis to warrant comparisons.

ARTESIAN WATERS.—A paper on Geologic Basis for Artesian Prediction was presented by Mr. N. H. Darton, and one on Artesian Waters of the Atlantic Coastal Plain by Mr. Myron H. Fuller. Each of these papers went somewhat exhaustively into its respective subject.

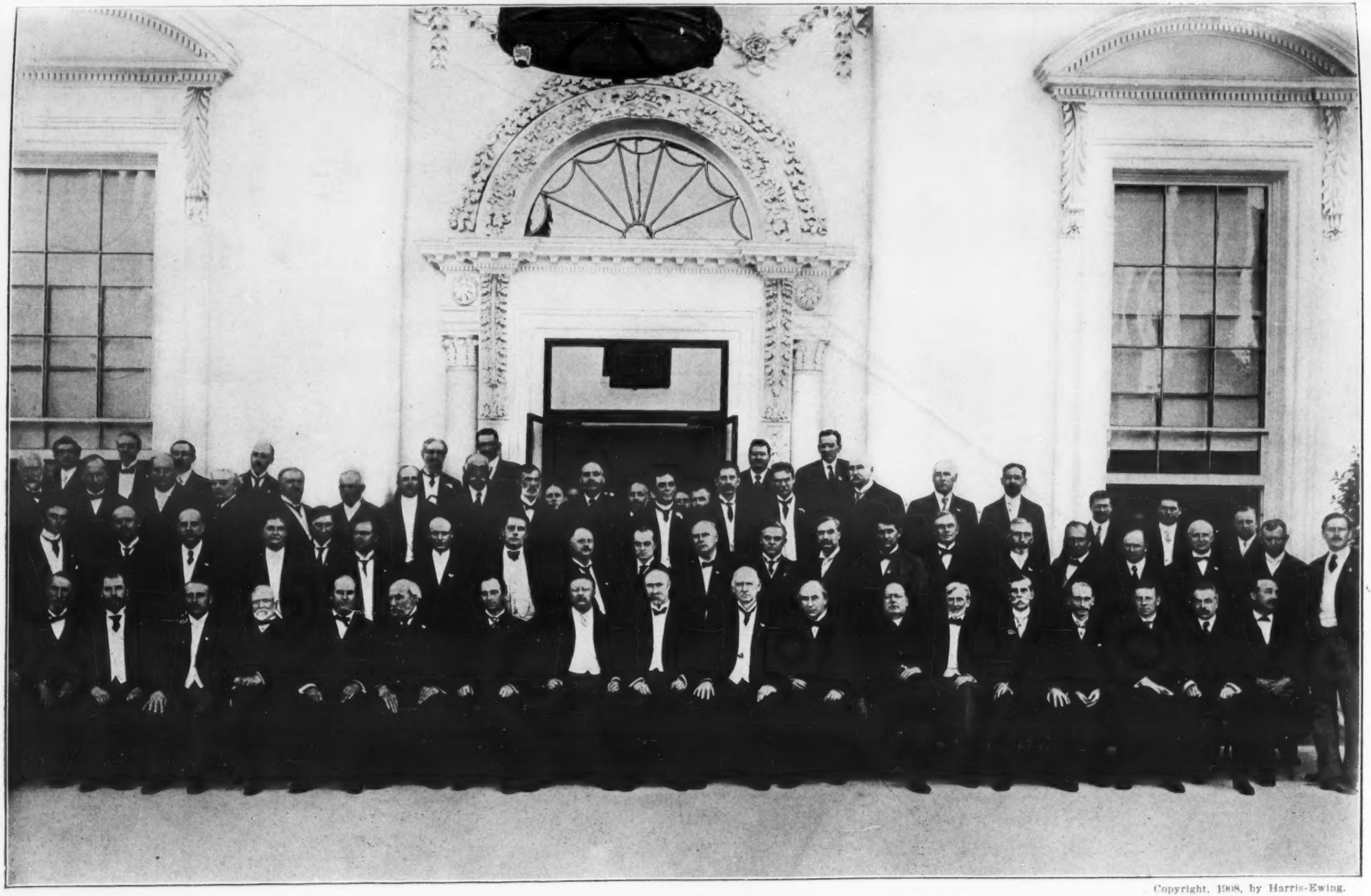
STRIPPING RESERVOIR LANDS.—Secretary Diven related two experiences with reservoirs: One built at Elmira, N. Y., in 1871-2 had the organic matter removed from the site, but notwithstanding this it gave trouble from organic growths from time to time. A mechanical filter plant installed in 1896 did not completely remove the odors and tastes, and was sometimes put out of use by the matter resulting from the growths. In 1904 copper sulphate was successfully used to prevent growths. This was used for about two years, when retreatment was necessary. A reservoir at Charleston, S. C., was built quite recently. The land flooded was composed largely of "black muck or decayed vegetable matter," and a large part of the drainage area was swampy. No stripping was attempted at Charleston, and even standing timber was left. Algae growths have been kept down with copper sulphate, and aeration has been employed to get rid of the effects of crenothrix. It is to be noted, as Mr. Diven states, that "the Charleston plant has only been in use about three years, so that the future has much to develop."

ENGINEERING DESIGN AND FOUNDRY PRACTICE.—Mr. W. R. Conard read a paper dealing largely with special castings. He advocated the careful consideration of "not only the working stresses that the various parts will be subject to in active service," but also the consideration of "the processes and strains to which they will be subjected during the process of manufacture, and until they reach their final form."

PICTURE PAPERS.—Besides the lantern-slide papers already mentioned, the following were presented: The Efficiency of the American Process of Filtration, by Mr. James M. Caird; An Instance of Lake Purification, by Prof. W. P. Mason; The American Desert and Its New Water-Works, by Mr. Arthur P. Davis (Chief Engineer U. S. Reclamation Service); and Water Problems of Mexico, by Prof. Edward Bartow. Mr. Davis' views and explanatory comments were a revelation to those who have not followed the development of irrigation works by the government and the marvelous results in the way of grains, roots and fruits that are following the application of water to the desert. The views of dams under construction were particularly interesting. Professor Mason's pictures and remarks related to studies of bacterial distribution in Lake Sebago between possible points of pollution and the water intake. Mr. Caird's talk and pictures were in the nature of an exhibit of mechanical filters of various dates and types, rather than a discussion of the efficiency of mechanical filtration. Professor Bartow showed some very interesting views of primitive and modern water-supplies in Mexico.

OPERATING A 16-IN. SIPHON AT RICHMOND, IND.—Mr. Howard A. Dill described an interesting installation for removing air from a 16-in. siphon three miles in length. A 42-in. × 12-ft. horizontal boiler, supported on concrete piers and enclosed in a frost-proof building, was installed over the summit of a 16-in. pipe. It was connected to the pipe by a 6 × 3-in. reducer and a 16 × 6-in. tee. The installation and its operation was described by Mr. Dill as follows:

> A 6 × 6-in. horizontal Clayton air compressor, connected by a noiseless link chain with a 2-HP. General Electric motor, is located near this boiler. The compressor has a 1½-in. outlet, and a 2-in. inlet, and has a rated speed of 150 r. p. m. and a discharge capacity of 29½ cu. ft. per min. The motor is shunt wound, and is rated at 800 r. p. m. A Halls-Canna lubricating pump is attached to the compressor to feed all bearings and the cylinder. On the inside of the boiler is a 10-in. copper float attached to a 3-ft. lever, to which is also fastened a ⅜-in. brass rod. This rod consists of two parts, one end being secured to the lever arm, the other passing through a stuffing-box at the top of the boiler, the two parts being connected by a hinge having a vertical and horizontal motion. The upper rod is fastened to a chain passing to a lever switch. This switch operates an automatic electric starting device, consisting of a solenoid current breaker and a rheostat. By this device, the current is switched on and off of the 2-HP. motor supplied by a 500-volt direct current obtained from the Dayton & Western Traction Co., which passes within one-half mile of this point.
>
> When the siphon line and boiler are filled with water, the float throws the lever switch and the current is cut out. As the air in the siphon gradually passes into the boiler, this float lowers with the water level, until the switch throws on the current, and the compressor again exhausts the air in the boiler. To avoid the possibility of the float not throwing off the current, thereby causing the water to be drawn into the compressor, the 2-in. outlet pipe was extended from the top of the boiler to a



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GOVERNORS OF STATES AND OTHER PROMINENT MEMBERS OF THE CONFERENCE ON THE CONSERVATION OF NATURAL RESOURCES; PHOTOGRAPHED ON THE PORTICO OF THE WHITE HOUSE, MAY 13, 1908.

(Those in the front row, from left to right, are: Governor Harris of Ohio, Governor Hughes of New York, Governor Davidson of Wisconsin, Andrew Carnegie, Wm. J. Bryan, Jas. J. Hill, John Mitchell, PRESIDENT ROOSEVELT, Vice-President Fairbanks, Justice Harlan, Justice Brewer, Justice White, Justice McKenna, Justice Holmes, Justice Day, and Justice Moody of the U. S. Supreme Court, Secretary Cortelyou, Secretary Bonaparte, and Secretary Garfield.)

heights about 40 ft. from the water level in the supply well to the siphon, and thence run downward to the inlet of the compressor. Ordinarily this arrangement would have been satisfactory, but soon after the apparatus was started, the float failed to operate, and water entered the compressor. In the opinion of the writer, this trouble was caused by the heavy volumes of air passing into the boiler from the siphon line, thence into the 2-in. outlet pipe, lifting a column of water equal to the volume of air discharged. To prevent a repetition of this trouble a float valve was placed at the entrance of the outlet pipe of the boiler, which will close the opening when the water level reaches this stage. To permit the filling of the siphon from the reservoir, a tee was placed in the pipe connecting the siphon and the boiler, and the usual check valve set on this branch. By means of valves on both connections, the air in the siphon can be removed by the compressor or by the reservoir.

The siphon was shut off at the pumping station on May 20, at 6 p. m., the pressure gage registering 6 lbs., and the rate of flow being 484,000 gals. for 24 hours. At 7.30 a. m., the air pump was started with vacuum gage showing 22 ins., the electric meter 52.3 KW., and the revolution counter 3363. At 8.10 a. m., the pump was stopped, the revolution counter requiring adjustment. The counter registered 5,470, and the electric meter 52.6 KW. At 1.30 p. m. the pump was again started, the counter registering 6,433, and was run until 5.30 p. m. On May 21, 7.30 a. m., the pump was started, and run until 10 a. m., when the air in the siphon and boiler was exhausted, the vacuum gage registering 16 ins., the pressure gage at the pumping station 40 lbs., the electric meter 58.3 KW., and the counter showing a total of 50,229 strokes of the air pump. The amount of current used was 6.3 KW., and the actual time of running was seven hours and ten minutes. The compressor discharges 339.24 cu. ins. at each full stroke, making a total discharge for the test of 9,862 cu. ft. or 22.93 cu. ft. per min. Cost of current at 8 cts. per KW. was 50.4 cts., or 5.11 cts. per 1,000 cu. ft. of air discharged.

On May 22, at 8 a. m., with conditions the same as at the close of test on May 21, the pump was started with 16-in. valve at pumping station open eleven turns, and gage indicating 40 lbs. pressure. Test discontinued at 5.32 p. m. Counter showed a total of 6,284 strokes, or a discharge of 1,233.67 cu. ft. Current used was .9 KW., cost being 7.2 cts. Number of hours operated, 9½. Number of gallons discharged by siphon, 433,413, making rate of flow for 24 hours 1,075,000 gals. Cost of current per million gallons, 16.92 cts. Cost of current per 1,000 cu. ft. of air, 5.84 cts. Cubic feet of air discharged per million gallons, 2,899.2.

This apparatus has been in operation about one year, and is proving satisfactory. As the lead joints in the pipe line become tighter, it is believed still better results will be secured.

MAINTAINING TIGHTNESS OF JOINTS IN PIPE UNDER RAILROAD TRACKS.—In the course of a brief paper covering several "experiences," Mr. S. A. Gailey stated that he had had considerable difficulty on a line of water main passing under railroad tracks. A joint directly under one of the rails was blown out several times. The pipe was finally relaid so as to bring the joints between each set of tracks. No further trouble occurred and the pipe has now been in use four years. In another case, lead wool has been used to calk the joints, and has been found to hold for about a year.

Secretary Diven stated that after driving 60-ft. piles without finding bottom, in an effort to support pipe beneath the railway track in very soft ground, he had finally given up the attempt and used ball-and-socket instead of ordinary leaded joints. Mr. A. P. Folwell said he had enclosed pipe beneath railway tracks in larger pipes, and that defective pipe could be used for this purpose.

LEADITE.—The question having been raised as to the use of leadite as a substitute for ordinary lead joints for cast-iron pipe, a number of members recounted satisfactory experiences. One superintendent had laid some 16 miles of 12 and 16-in. pipe with leadite, the pressure on the mains being from 85 to 95 lbs. There were some leaks directly after the pipe was laid, but none later on and no trouble had been experienced during the six months just past. Mr. R. N. Ellis said that he had laid a considerable length of pipe with leadite during the past two years, with satisfactory results. Two lines under railroad tracks laid with leadite have given no trouble as yet, but ordinary lead joints beneath railroad tracks have to be recalked about once in 30 days. Several speakers agreed in testifying that leadite costs less than ordinary lead for calking, and that with it joints can be made more quickly.

OTHER PAPERS.—As has already been intimated, the program was very lengthy. A large number of the papers were short and many of these were particularly valuable for such a convention, dealing as they did with problems encountered in every-day work.

President Felix told of difficulties that had been encountered in Pennsylvania in selling water to private companies or individual consumers outside of municipal limits. The court decided in one case that water commissioners had "no power to sell water to the water companies, to be again sold to customers of theirs outside of the city." A subsequent legislative act authorizing such sale was vetoed by Governor Pennypacker. The specific questions raised appear to have been largely confined to Pennsylvania, but Mr. Felix discussed in addition some of the general principles involved in selling water outside of municipal limits.

Mr. C. W. Wiles, in a paper on Ownership of Public Utilities, discussed some of the phases of municipal ownership. He urged that municipal water departments should be paid for service rendered to other departments, and deplored unfair and unreasonable means employed against water companies in cities desiring to change to public ownership.

Mr. J. T. Sawyer outlined some of the Tribulations of a Private Water-Works Man. Among his own particular troubles was the development of a small private water-works plant against local claims that such an enterprise was needed or financially feasible, followed by an attempt to secure municipal ownership of the works at a very inadequate valuation, as he believed, after the works were on a paying basis.

Mr. Charles R. Henderson, in a paper entitled "Competitive Water-Works," gave a general outline of such works in the United States and followed this with a review of experiences in competition at Millville, N. J., Owensboro, Ky., and Sioux Falls, S. D. A proposal to build municipal works at Council Bluffs, Ia., to compete with an existing private plant, was also reviewed. The author pointed out a tendency, on the part of those responsible for municipal attempts at competition with private works, to greatly underestimate the cost of establishing a competing plant.

Mr. Thomas Stone told how he had succeeded in collecting water rates for a small private company which had previously conducted the matter in a very easy-going fashion. The secret of his success was in making every consumer sign a contract for water service, and rigidly turning off the water if the rates were not paid.

Other papers which at this time can be mentioned by name only were as follows: Copenhagen Water-Works, by Prof. W. P. Mason; The Significance of Nitrogen in Its Various Forms in Water-Supply, by Mr. Frank E. Hale; Repairs to a 72-in. Steel Main Under 30 Ft. of Water, by Mr. A. W. Cuddeback; Washington Water-Works, by Mr. Francis F. Longley; Locating Leaks and Repairing a Broken Main, by Mr. George H. Robertson; A Water-Works Swimming Pool, by Mr. Willis B. Durlin; What Would Be a Proper Charge for a Service Under These Conditions, by Mr. Sidney C. Robinson.

OFFICERS AND PLACE OF NEXT MEETING.—Mr. D. W. French, Superintendent of the Hackensack Water Co., Weehawken, N. J., was elected President for the ensuing year, and Dr. William P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute, Troy, N. Y., was chosen as First Vice-President. Mr. J. M. Diven, 14 George St., Charleston, S. C., was reelected Secretary-Treasurer.

Milwaukee was chosen as the place of the convention to be held in 1909.

THE WRIGHT AEROPLANE, the trials of which were mentioned in Engineering News May 14, was wrecked on the sand dunes near Manteo, N. C., May 14, after what is reported to be a continuous flight of about eight miles. A change had been made in the steering gear, and it is said that by the operator's mistake the machine was directed to earth at full speed when it was intended to cause it to rise. Mr. Wilbur Wright, who was operating the machine, escaped unhurt, but the aeroplane was demolished except for the driving engine. The reticent attitude long pursued by the Wrights in regard to their aerial experiments is still maintained so that no authentic information on the construction of this machine is obtainable. In Engineering News, Feb. 20, it was noted that the Wright brothers closed a contract with the War Department for a "heavier-than-air" flying machine, capable of carrying two persons (350 lbs.) and fuel for a 125-mile flight at a speed of 40 miles per hr. and capable of remaining aloft for 1 hr. These specifications were printed in full in our issue of Jan. 2. Of the 200 days in which this machine was to be built only 80 now remain.

THE PARKER BUILDING FIRE: REPORT OF THE NEW YORK BOARD OF FIRE UNDERWRITERS.

On the night of Jan. 10, 1908, a fire broke out in the fifth story of the 12-story Parker Building, a supposedly fire-resisting construction, located on the corner of 19th St. and Fourth Ave., New York City and, despite the combined efforts of 25 fire companies, continued for about eleven hours, resulting in the death of three firemen, completely gutting the entire 12 floors and seriously damaging the integral framework of the building. In our first issue after the fire (Jan. 16, 1908, p. 73) we published an account of the conflagration with a description of the building and the causes that led to the disastrous effects of the fire, but this article, necessarily from the short lapse of time, could not be entirely complete or correct. Immediately after the fire the New York Board of Fire Underwriters, recognizing the importance of this first destructive internally started conflagration in a so-called fireproof building, instituted a rigid investigation into the construction of the building and the causes and effects of the fire. This report* has just been issued in pamphlet form and it forms a valuable addition to the study of fireproof construction. The material presented is altogether too lengthy for reproduction here, but a brief résumé will be given of the general description of the fire and the recommendations for future construction. Portions of this account are repetitions of our first article, but are here included for the benefit of those of our readers who have not access to the previous issue.

THE FIRE.—The fire was first discovered about 8 p. m. in the rear of the fifth floor, which was occupied by a woolen company. By the time the fire companies had their hose coupled up this floor was so full of flame and smoke as to prevent any effective fire-fighting. The intense heat and smoke kept the firemen from getting at the source of the fire, which gradually ascended to the top or twelfth floor until at about 10 p. m., a section of the building, 40 × 24 ft. in plan, collapsed from roof to basement, killing three firemen, injuring many more and carrying the flames to the lower floors, which heretofore had not been attacked. Several minor collapses occurred after this first one, and the course of the fire was not stopped until it practically burned itself out about 7 o'clock the next morning. Although 25 fire and five truck companies were present, their work was principally confined to preventing the spread of the flames to adjoining buildings, as the smoke and flame-choked stairways could not be used to fight the interior fire and no adjoining buildings were very convenient for directing the hose.

CONSTRUCTION OF THE BUILDING.—The Parker Building is a 12-story and basement skeleton-frame building, built in 1900, originally designed for mercantile purposes, and so used; large quantities of carpets, rugs, woolens, inks, printers' supplies and stationery being stored on the various floors. It is about 121 × 150 ft. in plan and 175 ft. high, with a rectangular recess in one corner about 40 × 50 ft. in plan. The main frame is of steel I-beam girders bolted to brackets on cast-iron columns, which are founded on concrete bases. The interior columns are circular, varying from 15 ins. in diameter and 2 ins. thick at the basement to 8 ins. in diameter and ⅞-in. thick under the roof. The wall columns are rectangular in section. The floor system consisted of flat side construction 8-in. semi-porous tile arches spanning, in 6-ft. and in 7-ft. spans, between 12-in. I-beams, fastened in turn to 15-in. I-beam girders, which are bolted to the columns. These floor arches did not cover the bottoms of the 15-in. girders whose only protection was the 1½-in. plaster ceiling laid directly to the bottom of the tiling. This system was strong enough to stand about 120 lbs. per sq. ft. in its framing, but the arches were lamentably

*Report on Fire, Jan. 10, 1908, in Parker Building, Southeast Corner 19th St. and Fourth Ave., New York City. By W. C. Robinson, Chief Engineer of the Underwriters' Laboratories (Chicago) of the National Board of Fire Underwriters. New York: New York Board of Fire Underwriters. Paper; 5½ × 8¾ ins.; pp. 24; 31 plates.

weak for any live loading they would be liable to get. Fireproofing consisted of porous tile fastened to the circular columns in very insecure fashion and 3-in. tile partitions, jointed by and footing on timber strips. Open elevator and stair shafts extended up through the building and a large number of the windows, particularly on the rear court or recess, were not shuttered or wire-glazed. Poor fire-fighting appliances were to be found in the building, and the fire gained such headway that even they could not be used.

EFFECT OF FIRE.—The fire completely gutted the building of its contents and of all the timber fittings to partitions, doors, windows, etc. About 21% of the floor arches were more or less completely destroyed, for the most part from the fire alone, but in some cases from falling loads, such as presses, safes, etc., which broke through the floor system when the tiles became weak from overheating. The fireproofing was stripped from most of the columns, partly on account of the insecure fastenings and partly from the expanding wire ducts which were placed between the column and its protection. One column collapsed from roof to basement, carrying down with it an increasing amount of debris which largely added to the destruction of the framework. This column was found in pieces in the basement, but the collapse has been traced to the fifth floor portion, where the excessive heat weakened the cast-iron to sudden failure.

The condition of the building after the fire is probably best illustrated by the table of losses given below, prepared by the Board of Fire Underwriters. The stock in the building was totally destroyed. As it stood after the fire had been put out, the building was completely gutted from roof to basement. Floor arches were broken out on all floors, one panel of columns collapsed for its whole length and another, for a space between several columns, on the top two floors. Floor beams and girders were sagged in many places, but except where the falling material sheared off the cast-iron brackets, they were still in place. The walls and wall columns were not damaged to any great extent except where the intense heat splintered the window stone.

STRUCTURAL LOSSES IN PARKER BUILDING.

	Sound Value.	Loss Value.	Per-centage.
Carpenter work, hardware, paint and glazing	$88,249	$84,000	95.2
Cut stone	21,298	1,125	5.3
Electric wiring and equipment	20,000	9,500	47.5
Electric light fixtures	1,500	1,500	100.0
Elevators	22,500	14,500	64.4
Fireproofing, floor arches and partitions	44,502	40,182	90.3
Heating	15,151	9,000	59.4
Iron work	131,000	34,500	26.3
Mason work (including painting brick work)	95,154	23,966	25.2
Marble tile and terrazzo	11,931	10,750	90.1
Plastering	27,713	27,713	100.0
Plumbing	11,000	9,200	83.6
Roofing and sheet metal work	7,650	7,000	91.5
Terra cotta	13,800	3,960	28.7
General contractor's profit and architect's fee	51,295	27,839	54.3
		$304,735	
Cost removing debris, including iron work, floor arches, partitions, etc., and also including shoring, bracing, etc., to make the building safe previous to reconstruction	....	64,265	....
Totals	$562,743	$369,000	65.5

TEMPERATURES DEVELOPED.—The extremely high temperatures developed all over the building are worthy of note. The report says:-

Careful examination of the metals and materials in the various stories shows that the maximum temperatures reached in this fire were seldom lower and often higher than those developed in the average fireproof building in the Baltimore and San Francisco conflagrations.

Glass, brass electric fixtures, and lighter brass parts on typewriters and machinery, fused freely at many points in most all stories above the fifth. (Temperatures estimated at 1,400 to 1,800° F.) Copper wire was not so generally fused, but incipient fusion (slightly in excess of 1,900° F.) was noted in several places in the seventh, eighth and ninth stories and a fairly large stranded copper cable was melted by heat from the fire at several points in the rear of the eleventh story.

The highest temperature noted in any story (estimated at slightly in excess of 2,000° F.) was in the northwest corner of the eighth, where the cast-iron frame of a typewriter was fused. This was the only case where any signs of fusion were observed in cast-iron, although presses and machines were examined wherever accessible. Brass castings having heavier sections were rarely fused, although steam valves had reached the brittle point in a number of places and brass fixture arms were broken into short sections by their own weight and were melted in several stories. The temperatures were more uniformly higher in the eleventh than in any other story in the building. The south stairs and elevators were subjected to comparatively little heat, but the condition of the steel in the east stair and elevator shafts shows the effect of temperatures quite as high, if not higher, than in any other part of the building.

The temperatures rarely exceeded 1,900°, but were probably in excess of 1,800° for considerable periods in several stories. The amount of quenching by means of outside streams had a material influence on both the severity and duration of the fire in stories below the tenth, but the opportunity for the application of water from near-by buildings was comparatively favorable.

The observations made indicate that in buildings of large area containing considerable quantities of combustible material, the fireproofing should be capable of withstanding temperatures as high as 2,000° F. for several hours.

RECOMMENDATIONS.—The character of the building and the causes and extent of the damage resulting from the fire are probably better illustrated by the recommendations for future practice than by any detailed account of the particular instances from which these deductions were made. These recommendations were made by Mr. W. C. Robinson, who had charge of the investigation, and while being largely based upon the specific observation of the Parker Building before and after the fire, they are to some extent the result of a study of similar conflagrations during the past. They embody the latest ideas on structural fireproofing, both in regard to the general design of the building and the specific defense against damage from the fire.

The recommendations are as follows:

1. In buildings of mercantile, manufacturing or storage occupancy, it is absolutely essential that all vertical openings be thoroughly enclosed in *substantial* fireproof shafts having standard fire doors at all openings or so arranged that the shaft is without openings directly into the various stories. Unprotected vertical openings through buildings are the greatest factor in the loss of life and property by fire and the proper safeguarding of this hazard demands the most careful attention of all concerned.

2. The height of fireproof buildings of mercantile, manufacturing or storage occupancy should be limited to correspond to the degree of protection the Building Equipment and the Fire Department is able to furnish. In other words, if adequate fire protection in any building is not available above a certain height, the building should be limited to such height.

3. Buildings of large unbroken floor areas filled with combustible contents develop the severest fires and constitute one of the most dangerous sources of general conflagration. Floor areas in buildings of this character should be subdivided by substantial brick fire walls sufficient to form a positive barrier to the spread of fire.

4. Fireproof buildings, no matter how well designed and constructed, do not prevent the destruction by fire of contents in any story; and it is essential that high buildings of mercantile, manufacturing or storage occupancy be thoroughly protected by a standard equipment of automatic sprinklers.

5. Exterior openings in buildings should be thoroughly protected against exposing fires. Universal efficient fire protection of exterior openings will practically eliminate the danger of conflagration in cities.

6. High buildings of mercantile, manufacturing or storage occupancy should be provided with large, properly enclosed stairways in sufficient number to afford safe exit at time of fire. Such buildings should also be provided with outside fire escape and standpipe equipments.

7. Buildings of mercantile, manufacturing or storage occupancy should be provided with adequate systems of inside standpipes equipped with linen hose and nozzles suitable for fire department use, and, in addition, a smaller linen hose and nozzle suitable and safe for the use of occupants. These equipments should be accessible and in sufficient number to effectively cover all portions of the building. They should extend through all stories and should be supplied from a reliable source of water under adequate pressure, in addition, to siamese steamer connections on the outside at street level.

8. The use of perforated pipe systems should be prohibited, as such systems are unreliable, inefficient and liable to result in water damages wholly disproportionate to the extent of fire. Where it is desirable to protect only a part of a building, a system of automatic sprinklers with adequate water supply should be employed and the portions protected plainly marked at the siamese steamer connections on the outside of the building.

9. Cast-iron columns should not be used in high buildings, as their failure is usually complete and results in sudden total collapse of the sections supported. Girders and beams cannot be rigidly attached to such columns and defects in the material cannot be readily detected.

10. It is essential that all structural members of fireproof buildings be protected by a sufficient mass of fireproofing to thoroughly insulate them against the heat which would be developed by the rapid burning of all materials permitted in any story of such buildings. It is also essential that all fireproofing be firmly anchored, or otherwise securely held in position, where it is of such a nature or so designed that it will become loose as a result of heat. On account of their great importance structurally, columns should be insulated by at least four inches of fireproofing; and no pipes or conduits should be placed in or back of the fireproofing material. On account of the heavy mass of fireproofing with which girders and floor beams are in contact, a lesser amount of protection can be safely employed at the soffits. Generally this should not be less than two inches for girders and one and one-half inches for floor beams.

11. All floor arches should be provided with a large factor of safety so as to safely carry the imposed loads, not only under ordinary conditions, but when severely exposed by fire.

12. Arches of all forms in common use are seriously damaged when directly exposed to high temperatures of long duration. In buildings containing large quantities of combustible material, they should be so designed or protected against fire that serious structural damage will be prevented.

13. No wood or other combustible material should be employed in the construction of fireproof partitions and all metal supports or reinforcements should be thoroughly insulated from heat. Fireproof doors and wired glass in standard metal frames should be used at necessary openings in corridor and room partitions. Provision for expansion in the material used and in metal supports entering into the construction of fireproof partitions is essential, particularly where hollow terra cotta blocks are employed. All fireproof partitions should rest on solid incombustible material.

14. In buildings of fireproof construction all floor surfaces, doors, window frames, sash and other trim and finish should be of incombustible material.

15. The support of heavy safes and machinery on wood floors and wood skids in fireproof buildings is a menace to both life and property, and should be absolutely prohibited. Heavy shafting should be attached to ceilings in such a manner that it will not fall as a result of fire.

A DEFICIENCY IN THE NOMENCLATURE OF MINERAL DEPOSITS.

Mr. Henry Louis, M. Inst. M. & M., in a contribution to the Proceedings of the Institute of Mining & Metallurgy, calls attention to the fact that the English language is in need of a word which, like the German "Fallen im Feld," will define the obliquity of ore-shoots in the plane formed by the general dip and strike of the vein. The question is not merely academic: in the districts where this type of ore-deposit is common, especially in the smaller gold mines of western America, the location of shafts intended to cut the vein at a lower level is usually decided without any thought of the distance toward either end of the strike which the shoot may gain with depth. The dip alone having been considered, the pay-streak is missed, and expensive crosscutting becomes necessary.

The word "pitch" has in a few instances been used to denote this angle from the horizontal (usually approaching 90°) assumed by the axis of the shoot or lenticular body of ore, and Mr. Louis suggests that this term be adopted as the permanent designation for the phenomenon in question. This will on occasion render the technical expression of the engineer concise and clear, and its existence will to some extent obviate the possibility of oversight of the physical condition pointed out.

THE SANTA FE TUNNEL THROUGH RATON MOUNtain is now reported finished at a cost of $1,000,000. The contract date for completion was in April and the contractors have since that time lost a forefeit of $100 per day for the delay.

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The hardest fight of the good-roads movement is still largely a thing of the future. That movement, steadily progressing, now engages the expenditure of millions of dollars per year, and the money is spent to excellent effect. Yet at the same time much larger sums go each year to the so-called "repair" work on minor roads, those controlled by the townships. The township road money is practically all thrown away. To save it to the benefit of the roads by diverting it to the efficient county or State road improvement can accomplish more for good roads than all that has yet been done.

The township road repair work is directed by men who know little or nothing about road construction or road maintenance. It employs methods that are more suitable for spoiling a road than for improving it. The work is performed not in the season when the roads need the work but in the season when there happens to be the most leisure. In every respect it is a perfunctory, profitless piece of business. Spring is the time when road work *should be* done; autumn is the time when it *is* done. In spring all hands are busy with their private occupations, while in fall, after the last of the harvests are cleared away, time is available in plenty. The results of the fall road work are speedily wiped out of existence by the weather of early winter, except as some remnants survive to roughen the road and impede its drainage all through the winter and often far into the following summer.

There is no better evidence of how bad the prevailing conditions are than the fact that every piece of "repair" work on a township road remains a bad spot for months afterward, and, conversely, that every rough place in the road is a sure indication of recent repair work.

The unfortunate thing, however, is not the existence of these rough spots, but the waste of the money spent for "repairing." Could we eliminate the township work altogether, the roads would not only not suffer but be actually bettered; but, also, what is much more important, millions of dollars would be saved which might be employed with most excellent results to extend the macadamized network. The year's fund for good-roads work, the country over, would be at least doubled if the money wasted on the township roads were applied to it.

The rural districts have progressed beyond the stage where the local attention of the township is needed to apply crude and primitive repairs in order that the country roads may be kept open at all. Under the precarious conditions of earlier years, the few dollars of annual expenditure per square mile which were needed to barely maintain traffic could be spent most economically, and quite efficiently, by the local authorities. Now, however, the continuance of the system means merely that the money is spent by incompetent hands in a perfectly useless way.

To rescue these road moneys—an enormous sum in the aggregate—and apply them to effective road improvement, is as profitable a task for the friends of roads as any they can undertake. The money is a proper tax, that is to say we are not spending too much for roads by any means; but we may properly demand that it be spent usefully. There is little satisfaction in contemplating the excellent results of good-roads work when at the same time we know that its efficiency is cut in half by the dead waste of local road repairs as now conducted.

The final and authoritative report of the New York Board of Fire Underwriters on the Parker Building fire, abstracted on another page of this issue, confirms the first impression that so complete destruction could not have resulted in a well-designed and thoroughly constructed fire-resisting building. The fire and the subsequent investigation indicate that many city buildings, particularly of the warehouse and storage type, are masquerading under the terms "fireproof" and are viewed by many with falsely founded security because of some few attempts at fire-resisting details.

In any building there are three successive lines of defense against total destruction by fire; first, to keep the fire from starting; second, to keep it from spreading, and, third, to prevent it affecting the structural integrity of the framework. In the Parker Building all three of these lines were very weak. The combustible nature of the goods stored on the various floors changed the building from the office type to the mercantile, though this does not seem to have been impressed on those responsible for its fire protection, and the presence of these goods made an efficient watchman service and an ample sprinkler system most obvious precautions. With these safeguards absent, the fire started and spread over considerable space before being discovered and the first line of defense was passed. The fire once started, structural conditions favored its rapid spread. The lack of fire-fighting facilities in the building and of fire-escapes from which the fire could be fought, the open staircases acting as flues up which the flame was drawn, the unprotected windows by means of which the fire climbed from story to story, the large open rooms for the free spread of the flames, all show the lack of the second line of defense. Finally, the construction was insufficient to resist the attacks of a fire, made possible by the incorrect layout and design. The light floor arches, the ineffective column protection, and the cast-iron columns combined to cause localized failures, the debris from which, dropping from story to story, wrecked many times as great an area as that destroyed by fire alone. So the third line of defense was neglected and a 65% structural loss results.

This is no new story in its general features; the principles involved are the very groundwork of fireproofing engineering, but the loss has been so complete that the application of old truths becomes impressive. However, the Parker Building fire is unique in one way. Heretofore, there has been a general feeling of security in the semi-fireproofed condition of the isolated building. It has been said that human ingenuity could not devise a structure which would stand up against the attacks of a general conflagration, but that the ordinary fire-resisting building was safe as regards any fire started within its walls. As proof of this two recent cases are cited, in which remarkably intense fires have been confined to the floors on which they started. That these two buildings were safe is due to observance of the standards of safe construction; that the Parker Building failed at the crucial point is due to a carelessness of proper precaution all too common in many buildings, a precaution here shown to be quite as necessary as a safeguard against internal fire as against widespread conflagration.

In the very complete report of the underwriters attention might be called to three things in particular: the high temperature developed, the behavior of the cast-iron columns and the necessity for heavier column fireproofing.

The temperature now used in most fireproofing tests is 1,700° F., it being supposed that this is about the average of temperature which will be developed in a conflagration. In such intense fires as those at Baltimore and San Francisco the highest temperature rarely exceeded 2,000° F., and in ordinary fires the fused material found has indicated somewhat lower temperatures. In the Parker Building, on the other hand, an isolated fire averaged 1,800° F. and in one place, at least, developed a temperature of over 2,000° F. If this heat can exist, would it not be proper to specify a higher test temperature for fireproofing which possibly may be called upon to resist just such fire-conditions as occurred in the Parker Building?

The behavior of the cast-iron columns can hardly be called unusual. That such columns are liable to sudden and complete failure under high temperature has long been known, but the disastrous consequences of such collapse has rarely been more clearly illustrated than in the interior column noted in the report, the failure of which spread the flames to the lower stories and was so sudden as to carry down with it a number of firemen who had no warning of the danger. The failure of the columns was primarily due to the flimsy fireproofing protection, and the experts, in recognition of this, have recommended for a standard in such construction, a 4-in. thickness of tile; a considerable increase over current practice. But even with the light protection used, a steel column under like conditions would perhaps have buckled, but would not have collapsed, and the complete destruction of the lower stories would have been avoided and the lives of three men saved.

THE RESULTS OF THE CONFERENCE ON CONSERVING NATURAL RESOURCES.

A hundred and twenty-two years ago the first President of the United States invited the Governors of the several States to meet him in conference to consider the development of natural resources—the Potomac River as a waterway. Out of that Conference and the need which it made evident of "a more perfect form of Union" grew the Constitution of the United States.

In 1908 the twenty-fifth President of the United States, following the precedent set by George Washington, invited the Governors of the 51 States and territories now composing the nation, to a Conference to consider the Conservation of Natural Resources—the preservation of Nature's gifts for the benefit of posterity.

That Conference, held in the White House in Washington on Wednesday, Thursday and Friday of last week, and presided over by President Roosevelt, seems likely to be the beginning of a movement out of which will grow public benefits quite comparable with those that have resulted from the Federal Constitution. That great instrument gave us a stable and efficient Government, the greatest blessing that a civilized people can possess. But life itself—the life of the human race upon this planet—is conditioned on a supply of food, raiment and shelter; and the Conference of last week was held to consider how the foundation sources out of which these elemental necessities of life are produced may be preserved for the benefit of coming generations.

It has been quite generally understood by scientists and engineers for a considerable time that our present day civilization has set a pace in using up Nature's stored treasures that was cer-

tain soon to exhaust them. But the few voices raised in warning have been voices of those crying in the wilderness. People in general have no conception whatever of the fact that there is a limit to the amount of stored fuel and metal and mineral, and that the world may suddenly awake one morning to find itself cold and hungry and Mother Nature's larder empty. Even intelligent men turn warnings like these aside with the cheerful assurance that new discoveries will be made and inventors will devise substitutes as one and another product grows scarce.

There is no doubt that further discoveries will be made of additional mineral resources, and that invention and ingenuity will do much to help put off the evil days of want that are surely coming. But inevitably, sooner or later, the mineral deposits in the few hundred feet of rock near the surface of our planet, which are alone available to man, will be exhausted. Engineers know well that inventors never work miracles, that no inventor ever made or ever will make something out of nothing. Substitutes may be developed; but the substitute is seldom as good as the original.

There is another reason why people in general are blind to the coming exhaustion of Nature's resources. It is this. In the development of our complex social system we have removed the consumer so far from the sources of production that he is densely ignorant whence the raw material for his sustenance comes. All he knows is that by paying the price he can always buy the thing he wants; and prices depend on too many variables for him to discover in rising prices the warning of actual scarcity approaching.

Thus the utterances of those who foresaw coming disaster have been little heeded. Waste and destruction have gone on for half a century at least in a manner which some future generation will look back upon as one of the greatest crimes ever committed against the welfare of the race. It was evident that some measure must be taken to arouse and enlighten the public concerning this great question. A few scientists and engineers in the City of Washington, most of them members of the Inland Waterways Commission, were impressed with the great need that something be done to check the waste of natural resources. They enlisted the interest of President Roosevelt, and his invitation was sent out to the Governors of every State in the Union to meet with him for conference on this matter.

It is well to note in passing that this is the first National convocation on this subject ever held. Of course other countries have given much study to various phases of the subject. The industrial nations of Europe have for years been closely watching their diminishing stores of coal and iron and husbanding their forest resources.

Each nation, however, has felt vaguely that when its own supplies ran short it could draw supplies from its neighbors; and it remained for the United States—the most wasteful of all nations doubtless—to awaken to the impending danger of world-wide scarcity and assemble representatives from all parts of its territory to discuss the situation.

Elsewhere in this issue we have reported the papers and other proceedings of the Conference in such detail as space permitted. Here we purpose only to speak of the results attained, and these results, we may say at once, were gratifying in the highest degree to those who had the success of the Conference at heart.

First and most important of these results was doubtless its educative effect. From one end to the other of the nation, and indeed of the world, has gone the story of the assemblage of the men most noted in public life to-day. Millions of people have had brought home to them the new idea that waste is a crime against the race; because starvation menaces the world if waste is allowed to continue. Thus will be laid a sure foundation of enlightened public opinion in support of the radical legislation, State and National, that must be enacted and enforced to avert the threatened peril.

There were many members of the Conference who looked for results of a different sort, such as action with reference to pending legislation in Congress. There is no doubt that a large majority of the delegates were anxious to support a resolution urging the passage of the bill creating the Appalachian and White Mountain Forest Reserves, for example. There were many strong references in the discussion to the opposition which that bill has met.

Yet there can be little doubt that the Conference will loom larger in the public mind and will wield a wider measure of influence because it confined itself to the general problem before it and considered only broad questions of public policy touching the subject of its deliberations.

Even before the Conference met, it was fully realized that the details of the problem could not possibly be taken up and solved by any such assemblage. To many, if not most of the delegates, the problem was a wholly new one. Men confronted with a problem so new and so important could not in three brief days consider and adopt plans for remedying the evils and averting the dangers. In fact, no one is wise enough at the present day to say just what measures should be adopted at every point. The problem is so vast that few, if any, appreciate even yet the full measure of its significance, and the completeness of the change which must inevitably, sooner or later, come over our civilization.

In planning for the Conference, therefore, it was clearly foreseen that discussion of remedies would be mostly beyond its scope. Of course suggestions were made by some speakers such as the remission of taxes on lands used for forestry, the fostering of agricultural education and legal restrictions as to the cutting of immature trees on private lands; but the Conference as organized could not well undertake to pass even upon such details as these.

Neither could the Conference undertake any definition of the dividing line between State and National jurisdiction, as some newspaper writers had predicted might be done. There were, of course, certain allusions in the speeches to the necessity of preserving the State's rights inviolate,—always a safe platitude; but the Conference was not organized or planned as a deliberative body for either legislative or executive work.

The result of the Conference as embodied in the series of resolutions adopted in the closing session was exactly the result hoped for and expected. The resolutions were the work of a committee made up of the Governors of Louisiana, Utah, New Jersey, South Carolina and Wisconsin. The resolutions were broad in scope, emphatic and advanced in their tone and wise in their recommendation. Careful reading of these resolutions, printed elsewhere in this issue, shows that they do two things, first, they report the conditions that exist and point out the necessity for a remedy; second, they recommend certain actions which may be enumerated as follows: First, the holding of further national conferences to further consider the subject; second, legislation looking to the protection of forests from destruction, the prevention of waste in mining, the protection of water resources for irrigation, water supply, water power and navigation; third, they recommend the creation of commissions, State and National, on the Conservation of Natural Resources.

We believe this last recommendation deserves emphasis as the most important result of the whole Conference, aside from its educational influence. The creation of such Commissions, in fact, is the next forward step that should be taken to advance the work which the Conference began, and the step cannot be taken too soon.

The deliberations of the Conference clearly brought out the need, first of all, for broader knowledge. Many men of national prominence confessed frankly in the Conference that the whole subject was a new one to them and they could only listen and learn and not pretend to give advice. The need for legislation, State and National, is evident, as was recited in the formal resolutions; but what form shall such legislation take? Is Congress or the State legislatures wise enough to frame and enact laws upon this subject? Do they not need the [illegible]sel and advice in every case of a commissi[illegible]ade up of men of high standing which could t[illegible]up this great question, investigate it with th[illegible] of the best technical experts and advise [illegible] action should be taken?

It may be stated here that prior [illegible] the assembling of the Conference a numbe[illegible] the engineering delegates who had the su[illegible] of the movement most at heart discussed to[illegible] what action should be sought for by the [illegible]ference that would yield the largest results. [illegible]as generally agreed that the thing to be [illegible] hoped for was the creation of a National [illegible]mission, made up of men representing all sect[illegible] of the country and all shades of political o[illegible]n; but standing so high in reputation that [illegible]r conclusions and recommendations would [illegible]mmand respect and popular support. Such [illegible]commission could bring together the data already collected by State and National scientific bureaus and independent investigators, could supplement where necessary by independent investigations of its own and could in a comparatively short time give the Nation an inventory of its stock of land and forest and mineral resources still available, such as is nowhere now available.

Such a commission could study possible legislation for conservation and so plan it as to effect the least interference with present methods and existing business. Such a commission could arouse and enlighten the public to the dangers of the present situation and the need for prompt and wise action. Without such educative work on public opinion, it is much to be feared that legislation will be slow, halting and frequently injurious rather than beneficial.

While most of the work we have outlined could be done far more successfully and economically by a single National Commission than by fifty separate State Commissions, the formation of such State commissions will also be highly advantageous. Such bodies would have far greater local influence in bringing about necessary State legislatfon than any Federal Commission. Cooperation between State and Federal Commissions could be easily arranged to avoid duplication of work and secure concentration of influence.

The creation of such National and State Commissions to investigate and advise as to the Conservation of Natural Resources is the next forward step to be sought; and it is to this end that every citizen alive to the dangers of our present wasteful and ruinous policy toward our natural wealth should exert all his influence.

LETTERS TO THE EDITOR.

Theoretical Stresses in Column Lattice.

Sir: This letter may explain to your readers the cause of the discrepancy between Prof. Morris' and the writer's communications regarding shear in columns.

The shear at right angles to the longitudinal axis of a beam or column is usually termed the vertical shear and the shear parallel to the axis is usually termed the horizontal shear, and these terms will be used in what follows.

The tension or compression from bending in the flange of a girder or column at any cross-section is the sum of the increments of *horizontal shear* transmitted to it from the web between a pivoted end (or a point of contrary flexure) and the said section. Prof. Morris in an article in your issue of Nov. 7, 1907, used this fact in determining a rule for proportioning the lattice bars of columns, but based the rule on the average instead of the maximum horizontal-shear increment. In your issue of Jan. 9, 1908, the writer criticized the rule referred to and pointed out that the ratio of maximum to average horizontal-shear increment in an eccentrically loaded column lies between $\pi/2$ (about 1.57) and 2. Prof. Morris in his reply (Eng. News, Feb. 27) agreed that the shear increment is not constant, but claimed that $\pi/2$ is the upper instead of the lower limit of ratio of maximum to average shear increment, and that for the lengths of columns used in practice the ratio is much less than $\pi/2$. He gave an analysis in support of his claim. In this analysis he dealt with *vertical* instead of *horizontal-shear* increments and thereby reached an erroneous conclusion in regard to the ratio given in the writer's criticism.

In view of the well-known fact that the intensities of the horizontal and vertical shear at any point are equal,

it may seem at first thought that the *increments* of horizontal and vertical shear would be equal. This, however, is not the case. The horizontal shear along the plane of the axis, between a point of inflection and a given transverse section, is equal to the tension or compression from bending in webs and flanges at and normal to said section; the corresponding *horizontal-shear increment* between successive transverse sections is equal to the vertical shear multiplied by the distance between the sections and divided by the distance between the centres of gravity of the tension and compression from bending in the webs and flanges. The *vertical-shear increment*, on the other hand, is the portion of the transverse load on a girder between the said successive transverse sections, or the component at right angles to the axis of the column of the direct compression parallel to the axis due to the change in direction of the axis between the said sections. For instance, in a 20-panel double-inclined girder resting on two supports, with 45° lattice, uniformly loaded, the successive *horizontal-shear increments* per panel would just equal the successive *vertical shears*, and the ratio of end to average horizontal-shear increment would be 1.0; while the vertical-shear increment would be a constant of one-twentieth of the load. In the case of an eccentrically loaded column, the ratio of maximum to average increment varies for the *horizontal shear* within the limits $\pi/2$ and 2, and for the *vertical shear* within the limits of 1 and $\pi/2$; the maximum *horizontal-shear increment* occurs at a pivoted end or a point of contrary flexure, while the maximum *vertical-shear increment* occurs at the point of maximum bending moment.

In your issue of March 12, 1908, the writer did not recognize the fact that Prof. Morris was dealing with the vertical instead of the horizontal-shear increments, and thus mistook the nature of the error, which consisted in treating the ratio of maximum to average vertical-shear *increment* as if it were the criterion, instead of using the ratio between the maximum and average *vertical shears themselves*, or, what amounts to the same thing, the ratio between the maximum and average *horizontal-shear increments*.

The practical phases of this question of maximum shear must not be lost sight of, however. It is most instructive to remember that the shear is proportional to the slope of the real axis of the column, provided the slope is measured with reference to the direction of the line of thrust. The reasonable possibilities as to the position and direction of the line of thrust and as to the curves and kinks in the real axis of the column, and the deflection of the column developed therefrom, should be allowed for in designing columns. No one simple rule can economically provide for all these possibilities. I therefore suggested a number of alternative rules for lattice in my letter of Jan. 9, 1908.

I am of the opinion that both the possible compression and the possible shearing stresses due to a given load, in columns with riveted or butt ends, will (if anything) decrease up to a certain critical length of column (see my article on Imperfect Butt Joints, Eng. News, Oct. 3, 1907). Beyond this critical length, owing to the increase in deflection incident to increase in length, the strength of columns decreases in a general way with the increase in length. The ordinary column formulas do not recognize any such critical length, but indicate a decrease in strength with each increase in length throughout the entire range. It is for, and only for, the lengths of column to which the ordinary formulas properly apply that I have suggested 2 as the safe ratio of maximum to average shear.

For such a case the slope of the true axis between points of inflection will be a combination of the original kinks or curves in the axis and a considerable deflection. One of the possibilities is that the final alinement of the axis may approximate a small arc of a circle or a parabola, in which case the maximum shear would be twice as great as the mean. If, instead, the curvature at the center is appreciably sharper than at the ends, the mean shear for a given deviation of axis from line of thrust will be about the same as before, but the maximum will be less. On the other hand, if the curve is sharper at the ends the maximum will be greater. This latter case is possible either by reason of the original curve in the axis or owing to kinks near the ends, but such a condition is much more noticeable and alarming in appearance than a circular curve. I therefore think it likely that the maximum deviation in the axis that would pass inspection would be produced by a nearly circular curve, for which, in combination with the deflection, the ratio of maximum to average slope lies between $\pi/2$ and 2.

While it has nothing to do directly with the question of shear, it is worth mentioning that lattice-bars rarely if ever intersect in the center of gravity of the channels they connect. This will result in local eccentricities and corresponding stresses in the channels between lattice connections, which is one of the reasons why lattice columns do not show up as well in tests as columns without lattice-bars. The local bending, also, will increase the deflection and thus increase the shear.

Yours truly, H. S. Prichard.

1526 Frick Bldg., Pittsburg, Pa., March 16, 1908.

The Grip on Reinforcement in the Compressive Area in Reinforced Concrete.

Sir: The values for the adhesion of concrete to steel reinforcement shown by the tests of Prof. L. J. Johnson, published in Engineering News, Aug. 15, 1907, p. 169, were remarkably high, the average for the rich mixtures being 1,094 lbs. per sq. in. Prof. Johnson attributes these high values to the peculiar loading of the beams which produced either a vise action on the ends of the rods or a deflection of the beams sufficient to interfere materially with the slip. The latter reason he deems the more plausible.

There are positions in which cantilever beams have a vise action on the reinforcement without the tendency to deflection that operated in Prof. Johnson's tests, for example, in retaining walls of the type shown in Fig. 1. As the regions *a* and *b* of the cantilever beams are in compression a vise action would cause a gripping of the rods as shown by the arrows. The amount of pressure gripping the rods is a question, but would probably be much more than the unit stress of concrete between the rods, because the modulus of elasticity of concrete being less than that of steel, the concrete would tend to compress more than the steel, thus throwing more pressure on the rods.

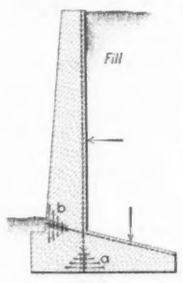


Fig. 1.

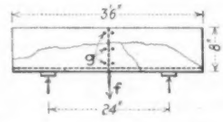


Fig. 2.

The writer wished to learn how the action mentioned above would result and accordingly made tests on reinforced-concrete beams similar to the one shown in Fig. 3. Each beam was 36 ins. long, 8 ins. deep and 6 ins. wide, reinforced with two straight ½-in. square twisted rods. In the middle of the bottom face of each beam was placed a ½-in. square twisted rod extending vertically up into it 7¾ ins. and projecting downward out of the beam several inches. The beam was supported at points 6 ins. from each end. The jaws of the testing machine were attached to the lower end of the projecting rod.

As in actual work the cantilevers shown in Fig. 1 do not act as separate narrow 6-in. beams, but as broad slabs; they have little or no tendency to split with cracks vertically as a result of the splitting action of the rods, for each 6-in. slice or beam has another on each side to react against its tendency to split. To place the 6-in. wide test beams in the same condition as if in a slab the six ¼-in. twisted rods were placed crosswise in each beam.

The beams were made of 1 : 2 : 4 mixture concrete. Their age was 66 days. The attempt to pull the projecting rods from the beams resulted as shown below.

The beams failed by rupture of the concrete along near the heavy lines drawn across them (typical of one of three beams). The beams were intended to be strong enough so that the rods would pull out before the beam broke. Such, however, was not the case as in every one the concrete held the rod until the beam failed by crushing or shearing of concrete.

On account of the rods not reaching quite to the top of the beam, observations could not be made of the time when the rods first slipped at that point if at all. In each case at the lower edge of the beam the rods had slipped from ⅛-in. to 3/16-in. before the failure occurred. But as the stress at that time had passed the elastic limit and approached near the ultimate strength of the rod considerable elongation must have taken place. So it was not thought probable that any slip had occurred at the top of the rod before the failure of the beam. There was no drop in the scale beam at any time to indicate that a rod had slipped as a whole.

While these few tests are not sufficiently extensive to warrant the use of the results in designing they are probably sufficient to show without doubt that when a rod is placed in the compressive region of concrete and pulled at right angles to the direction of the compressive stresses (as in Fig. 1) the gripping action largely increases its adhesion. They also indicate that this was the cause of the high results obtained by Prof. Johnson as no deflection of the rods tested could occur, yet the adhesion was about the same as his tests show.

Beam.	Pull at time of first visible slip at lower side of beam.	Ultimate pull at time of failure of beam.	Adhesion per sq. in. at time of first slip.	Adhesion per sq. in. at time of failure of beam.
No. 1.....	15,500 lbs.	20,200 lbs.	1,000 lbs.	1,303 lbs.
No. "	13,650 "	15,705 "	881 "	1,016 "
No. 2.....	13,500 "	18,650 "	887 "	1,203 "

Considering this action there are several points which might advantageously be considered in designing. (1) For such positions as shown in Fig. 1 the reinforcing rods should be run entirely through the beam into which they are anchored, as it is at the opposite side that the greatest vise action occurs, and it is possible that the elongation of the concrete on tension side of the beam may decrease the initial adhesion. (2) When this is done the adhesion is greater than for a rod in non-stressed concrete. (3) The higher the system is stressed the greater will be the grip on the rod. (4) If the beam be made thinner the surface for initial bond will be decreased but the vise action will be increased because, the moment arm of the resisting moment being made shorter, the compressive force will be greater. (5) The anchorage in such cases is safer, for should the usual skin adhesion be wanting or destroyed the vise action would still operate and would amount to as much as the coefficient of friction multiplied by the pressure exerted on the rods.

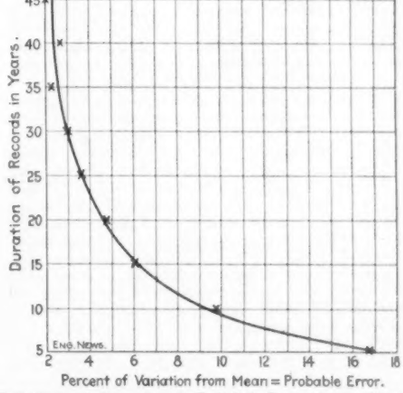
Yours very truly,
Frank A. Bone, President,
Concrete-Steel Retaining Wall Co.

Cincinnati, Ohio, April 25, 1908.

Variations in Rainfall Through Long Periods of Years.

Sir: As a matter of kindred interest in connection with "Length of Records Necessary for Determining Stream Flow," by John C. Hoyt, Assoc. M. Am. Soc. C. E., in Eng. News, Apr. 23, 1908, p. 459, I would like to call your attention to a 90-page paper, "On the Mean or Average Rainfall, and the Fluctuations to Which it is Subject," by Alex. R. Binnie, Proc. Inst. C. E., Vol. CIX., 1892, p. 80. I have picked out Table III., "Variations from the Mean of Shorter Periods, when Compared with the Mean Rainfall of the Total Period," and plotted a curve from the average of the data there given. The mean rainfall is the average of the means of 42 localities in Europe and America (principally the former) for periods of 50 to 97 years. The upper points of the curve are plotted from the average of but a few records, while the lower points are derived from the average of the 42 records.

A further interesting point is the fact that during the 97 years' record kept at Padua, Spain, from 1725 to 1821, the wettest year was 75% above the mean, and the driest year was 42% below the mean. The greatest number of consecutive years the fall of each of which was above the mean was nine, the average of this period being 18% above the mean; the greatest number of years the fall of each of which was below the mean was also nine, the average of this period being 22% below the mean. Of the 97 years, 49% had rainfall above the mean (17% above the mean) and 51% had rainfall below the mean (17% below the mean).



Relation of Length of Rainfall Records to Variations from Mean.

Yours truly, Clinton L. Bogert.

57 East 129th St., New York, May 2, 1908.

Notes and Queries.

In the article on the reinforced-concrete water tanks near Havana, Cuba, in our issue of April 30, 1908, p. 471, several errors in dimensioning crept in, owing to our misinterpretation of the original plans, which were prepared in Cuba and lettered in Spanish and the metric system. The walls, instead of being 12 ins. thick for their whole height, are 10 ins. thick for half their height and 8 ins. for the upper half. The 12 ins. shown on the drawing is taken through the pilasters that are under each horizontal beam supporting the dome floor. The

reinforcement in these walls consists of horizontal 1-in. bars, 6 ins. c. to c. at bottom and ¾-in. 12 ins. c. to c. at top, with vertical ½-in. bars 12 ins. c. to c. The 1½-in. rods shown in the dome floor should be ¾-in. rods. Mr. H. A. Young, from whom we received this description, wishes us to note that Col. Wm. M. Black, U. S. A., is responsible for the original suggestion of the dome-shaped floor to the tank.

THE COST OF NARROW-GAGE RAILWAYS IN AFRICA.

An extended report made to the German government (presumably by one of the government bureaus) on the subject of colonial railways, deals with the cost of railways in Africa. A note in the "Revue Generale des Chemins de Fer" gives this matter of cost in condensed form, from which we take the following particulars. It may be noted that the Cape Government Railways, the Natal Government Railways and the Central South African Railways, forming the largest railway system, have a gage of 3 ft. 6 ins., which may be termed the standard gage of Africa. In Egypt and other political divisions there are also lines of this gage. The Egyptian State Railways and the Algerian Railways have the European standard gage of 4 ft. 8½ ins., but the article from which we quote states that the result on the light railways (in Algeria) is a high first cost and a small return for the investment. We have shown in former articles that the width of gage is really a small factor in the cost of construction and operation. The West Algerian Railways, however, have a gage of 3 ft. 5 ins. The following table gives the gage and cost of several railways; most of these are of a pioneer character, but the Natal Government Railways form an important system. The Otavi Railway was described and illustrated in our issue of Oct. 10, 1907; its cost was there stated as $11,000 per mile (including tracklaying) while the table below gives the cost as $10,200 per mile. The cost of the different lines in different parts of the country necessarily varies greatly, according to the topography of the country, the character of the construction works, and other conditions. The lines of 2 ft. gage range from $10,200 to $27,420 per mile; the meter gage lines from $10,080 to $64,500; the lines of 3½ ft. gage from $14,640 to $84,270 (this last being for important lines of considerable traffic); the standard gage lines from $41,930 to $219,350. The highest figure for the 3½-ft. gage is for important lines of considerable traffic, and the highest figure for the standard gage must represent very exceptional conditions (probably construction in the earlier days of railways), as compared with the other lines.

Railways.	Gage. ft.	ins.	Cost per mile.
Otavi Ry. (German Southwest Africa)	2	0	$10,200
Swakopmund & Windhoek Ry. (German Southwest Africa)	2	0	15,800
Mayoumbe Ry. (Lower Congo)	2	0	27,420
Congo Ry.	2	6	52,420
Freetown & Baima Ry. (British Sierra-Leone)	2	6½	21,370
Togo Ry. (Coast Line)	3	3⅜	10,080
Ivory Coast Ry. (Bingerville to Kong)	3	3⅜	20,380
Lome & Palima Ry. (Togo District)	3	3⅜	25,800
Ousambara Ry. (German East Africa)	3	3⅜	29,840
Dar-es-Salam & Mrogoro Ry. (Zanzibar; German East Africa)	3	3⅜	37,500
Douala & Mangouba Ry. (Cameroons)	3	3⅜	42,840
Massoua & Asmara Ry. (Abyssinia)	3	3⅜	64,500
Egyptian private railways (not State lines)	3	6	14,640
Port Herald & Chimoro Ry. (Mozambique)	3	6	15,420
Tugela & Somkole Ry.	3	6	37,540
Natal Government Railways	3	6	84,270
Egyptian State Railways	4	8½	54,200
Algerian Railways	4	8½	$41,930 to $219,350

COST OF BRICK, CONCRETE AND PIPE SEWERS.

As resident engineer for Mr. T. Chalkley Hatton, M. Am. Soc. C. E., on sewer construction in Charleston, W. Va., aggregating about $175,000 in total costs, Mr. Clarence A. Bingham,* Jun. Am. Soc. C. E., prepared the accompanying tables, giving the itemized costs of the various kinds of works. The tables are complete in themselves and need no further explanatory comment.

*No. 302 Equitable Bldg., Wilmington, Del.

THE HOLMEN WATER-SOFTENING APPARATUS: PENNSYLVANIA LINES.

A new water-softening apparatus for railway water stations is now in experimental use at Indianapolis by the Pennsylvania Lines. The plant has a capacity of 30,000 gals. per hour, and was built in the railway shops at Indianapolis. According to information furnished by the railway company, the plant includes a settling tank or clear well, a mixing drum, a solution tank with lime slaking tank above, a solution pump, and a water motor, with the necessary piping. By chains and sprockets the motor shaft operates stirring appliances in the mixing drum and solution tank; it also operates the solution pump by an adjustable crank arm. When the raw water inlet is opened, the water passes through the motor, and motion is transmitted to the stirring apparatus and solution pump.

For each revolution of the motor, the pump makes one stroke. The length of the stroke and the strength of the solution (which at the Indianapolis plant contains lime and soda ash) are so adjusted as to deliver the proportion of chemicals necessary for the character of the water to be treated. The chemicals meet the raw water in the pipe connecting the motor to the mixing drum, and flow with it into the drum, where the water is agitated for about one minute before flowing through the pipe to the bell in the settling tank. The water passes under the lower edge of the bell into the settling tank, where it rises to the top and flows to the storage tanks through an overflow pipe. The chemical action is completed before the water leaves the bell. Pipes for removing the sludge are lo-

TABLE I.—COSTS OF MATERIAL AND LABOR FOR BRICK AND CONCRETE SEWERS AT CHARLESTON, W. VA.
(Compiled by Clarence A. Bingham.)

	72-in. three ring brick. Per lin. ft.	Special units.	72-in. three ring brick. Per lin. ft.	Special units.	72-in. reinforced concrete. Per lin. ft.	Special units.	54-in. reinforced concrete. Per lin. ft.	Special units.	48-in. concrete and brick. Per lin. ft.	Special units.	48-in. two Ring brick. Per lin. ft.	Special units.	42-in. two ring brick. Per lin. ft.	Special units.	36-in. two ring brick. per lin. ft.	Special units.	30-in. two ring brick. Per lin. ft.	Special units.
Depth in ft.	....	Tunnel	....	25	....	12	....	20	....	12	....	12	....	12	....	11	....	14
Material of excavation	....	Dry sand.	....	Stiff clay.	....	Clay.	....	Wet clay.	....	Wet clay.	....	Hard clay.	....	Wet and Dry.	....	Very wet.	....	Clay.
Method	....	See note A.	....	Hand.	....	Cableway buckets.	————		————		Carson Trenching Machine		————		....	Excavating machine.	....	Carson machine
Plowing and scraping	....	....	....	....	0.55	....	....	....	....	....	....	....	....	....	....	....	....	....
Plowing and scraping, per cu. yd.	....	....	....	....	....	0.27	....	....	....	....	....	....	....	....	....	....	....	....
Excavation	4.18	....	5.93	....	....	....	3.05	....	1.83	....	2.14	....	2.15	....	0.31	....	1.91	....
Excavation, per cu. yd.	....	1.40	....	0.58	....	....	....	0.61	....	0.68	....	0.79	....	0.80	....	0.18	....	0.73
Trimming	....	....	....	....	0.96	....	....	....	....	....	....	....	....	....	2.20	....	....	....
Trimming, per cu. yd.	....	....	....	....	....	0.99	....	....	....	....	....	....	....	....	....	4.16	....	....
Timber left in	1.34	....	....	....	....	....	0.59	....	....	....	0.12	....	....	....	....	....	....	....
Concrete bottom—material	....	....	....	....	0.48	....	0.76	....	0.42	....	....	....	....	....	....	....	....	....
Concrete bottom—material, per cu. yd.	....	....	....	....	....	3.58	....	....	....	....	....	....	....	....	....	....	....	....
Concrete bottom—labor	....	....	....	....	0.22	....	0.26	....	0.18	....	....	....	....	....	....	....	....	....
Concrete bottom—labor, per cu. yd.	....	....	....	....	....	1.65	....	....	....	....	....	....	....	....	....	....	....	....
Brick invert—material	....	....	....	....	0.70	....	0.45	....	0.50	....	....	....	....	....	....	....	....	....
Brick invert—labor	....	....	....	....	0.32	....	0.28	....	0.32	....	....	....	....	....	....	....	....	....
Brick—material	4.96	....	4.57	....	....	....	....	....	1.01	....	1.69	....	1.94	....	1.78	....	1.76	....
Brick—material, per cu. yd.	....	5.95	....	5.60	....	....	....	....	....	....	....	4.76	....	5.82	....	6.32	....	6.25
Brick—labor	3.67	....	1.73	....	....	....	....	....	0.60	....	0.90	....	1.04	....	1.02	....	0.91	....
Brick—labor, per cu. yd.	....	4.41	....	2.12	....	....	....	....	....	....	....	2.52	....	3.12	....	3.54	....	3.23
Placing forms and steel	....	....	....	....	0.06	....	0.04	....	....	....	....	....	....	....	....	....	....	....
Steel	....	....	....	....	0.71	....	0.61	....	....	....	....	....	....	....	....	....	....	....
Oil	....	....	....	....	0.02	....	0.01	....	....	....	....	....	....	....	....	....	....	....
Concrete arch—material	....	....	....	....	1.22	....	*1.67	....	....	....	....	....	....	....	....	....	....	....
Concrete arch—material, per cu. yd.	....	....	....	....	....	4.74	....	....	....	....	....	....	....	....	....	....	....	....
Concrete arch—labor	....	....	....	....	0.55	....	0.33	....	....	....	....	....	....	....	....	....	....	....
Concrete arch—labor, per cu. yd.	....	....	....	....	....	2.13	....	....	....	....	....	....	....	....	....	....	....	....
Backfilling	....	....	1.20	....	....	....	0.84	....	....	....	....	....	....	....	....	....	....	....
Backfilling, per cu. yd.	....	....	....	0.16	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cleaning up	....	....	....	....	0.12	....	....	....	0.09	....	0.11	....	0.08	....	....	....	0.09	....
Removing brick pavement	....	....	....	....	....	....	....	....	....	....	0.12	....	....	....	....	....	0.12	....
Special supervision	....	....	1.12	....	0.25	....	....	....	....	....	....	....	....	....	....	....	....	....
Total cost per lin. ft. in dollars	14.15	....	14.55	....	6.16	....	8.80	....	4.95	....	5.08	....	5.21	....	5.31	....	4.79	....

Note A—Tunnel excavation done by hand, loaded on cars and hauled by mule to shaft where it was raised by hoisting engine, dumped in wagons and hauled to place of disposal.

*Twice the required amount of concrete was used here.

Daily wages: Bricklayers, $5.80 and $6.00—Foremen, $4.00—Laborers, $1.75 to $2.00—Teams, $3.00 to $4.00.

Materials-unit cost: Cement, $1.85 bbl. on work—Sand, $0.80 to $1.00 cu. yd—Stone, $1.50 cu. yd.—Brick, $8.00 to $10.00 per thousand—Lumber, $22 per M.—Steel, $0.0238 per lb.—Oil, $0.18 per gal—Coal, $3.00 per ton.

TABLE II.—COSTS OF LAYING PIPE SEWERS AT CHARLESTON, W. VA.
(Compiled by Clarence A. Bingham.)

Method Used in Excavating.	Soil.	Size. ins.	Depth. ft.	Costs per ft. Mach.	Labor.	Materials.	Total.	Cost of Excv. cu. yd.	Rate, day ft.
Hand	Hard Clay	24	10	....	1.24	1.17	$2.41	$0.82	41
Hand	Clay	20	8	....	0.80	0.68	1.48	0.72	32
Excavating Machine	Wet Clay	18	10	0.23	0.56	0.60	1.39	0.28	91
Hand	Clay	18	12	....	1.12	0.52	1.64	0.98	30
Excavating Machine	Clay	18	13	0.20	0.56	0.52	1.28	0.18	133
" "	Wet Clay	15	11	0.26	0.38	0.39	1.03	0.27	70
" "	Wet Clay	12	11	0.20	0.39	0.27	0.86	0.22	151
" "	Clay	12	10	0.16	0.21	0.25	0.62	0.19	200
Hand	Clay	12	9	....	0.69	0.29	0.98	0.92	50
Excavating Machine	Hard Clay	10	8	0.18	0.20	0.24	0.62	0.24	190
" "	Clay	8	8	0.14	0.16	0.18	0.48	0.21	166
" "	Wet Clay	8	10	0.19	0.26	0.19	0.64	0.23	175
" "	Wet Clay	8	12	0.22	0.31	0.19	0.72	0.22	155

Large terra cotta pipes are figured at 70% off list price, and smaller sizes at 75%. The excavating machine was rented for $35 per day, plus 5 cts. per cu. yd. excavated at less depth than 10 ft., and 10 cts. cu. yd. for greater depths.

cated in the bottom of the settling tank and connected to the waste discharge. The raw water inlet and the sludge pipe are connected with a by-pass pipe, having the necessary valves. Water can be let thus directly into the settling tank, for stirring up the sludge or when the machinery is under repair.

The plant does not include filters, as it was thought that the complete settlement of the precipitate would be effected without them. Floor space and pipe connections are provided, so that sand filters can be put in if desired. All the machinery is on the ground, and the apparatus is of simple design. It requires little work for operation and maintenance, and is said to have given satisfactory results during the eight months it has been in operation. The plant was designed by Mr. A. R. Holmen, Chief Draftsman in the Motive Power Department of the Southwest System of the Pennsylvania Lines, and inventor of the Holmen coal handling plant for railway coaling stations.

CONCRETE FOUNDATIONS IN SHIFTING GROUND.

At Boomer, W. Va., the Boomer Coal and Coke Co. built, in 1903, a plant at their mine No. 1 to handle the coal from the head-house of the mine to a storage bin in a tipple some 650 ft. down the mountain, which at this point has an average slope of about 25°. The principal part of this plant was a chain conveyor carried down the mountain on a timber trestle with bents spaced 10 ft. c. to c. and founded on earth which had been deposited some years before from a slip about 400 ft. up the slope. At the time of erection the foundation was apparently solid and stable but after the plant was finished and in operation some few months the earth on which rested the timber footings of the conveyor and head-house showed signs of moving. Especially after two or three days of heavy rains the earth for a distance of 300 ft. on either side of the trestle would creep as a body several inches down the hill, with consequent upheaval of the timber and displacement of the conveyor, necessarily shutting down the entire plant for repairs. These slips became finally so numerous that the Reinforced Concrete Construction Co., of Cleveland, O., was called in by the coal company to devise some means to remedy the difficulty. Investigation showed that underlying the surface earth at depths varying from 20 to 55 ft. there was a ledge of solid rock and it was decided to replace the timber footings by building, founded on this rock, three reinforced-concrete piers to carry the conveyor and nine similar piers on which to found the head-house.

Fig. 1 shows the design of the middle of the three piers under the conveyor; the other two

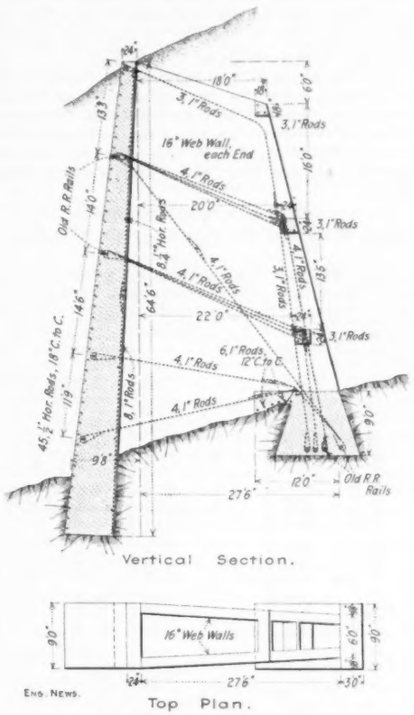


Fig. 1. Reinforced Concrete Pier for Coal Conveyor, Built in Shifting Ground.

All masonry is of concrete reinforced with twisted square rods and, in the face wall and rear footing, with old rails laid horizontally. The reinforcement is efficiently tied together by interlocking hooks, wired down.

The head-house foundation is shown in Fig. 2. It consists of a box-like structure of nine bat-

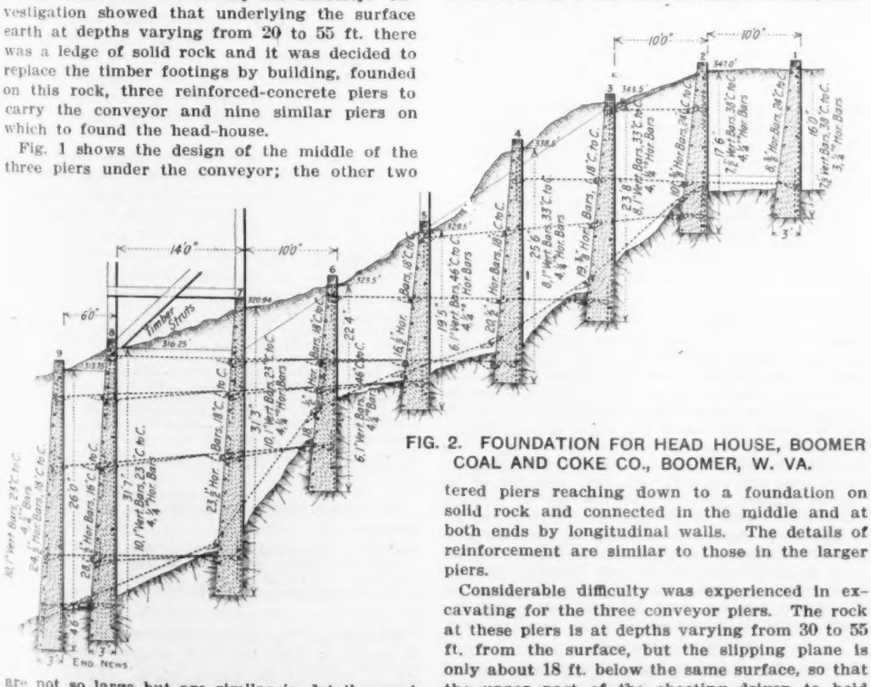


FIG. 2. FOUNDATION FOR HEAD HOUSE, BOOMER COAL AND COKE CO., BOOMER, W. VA.

are not so large but are similar in detail except that on account of a side slip near the top of the hill the pier next below the head-house is built at an angle to the line of the conveyor. Each pier consists primarily of a lower retaining wall which is founded on solid rock and which bears on its top surface the timber bent supporting the conveyor span. This head wall is tied back up the hill to another solid footing by wing walls which in turn are connected by cross beams.

tered piers reaching down to a foundation on solid rock and connected in the middle and at both ends by longitudinal walls. The details of reinforcement are similar to those in the larger piers.

Considerable difficulty was experienced in excavating for the three conveyor piers. The rock at these piers is at depths varying from 30 to 55 ft. from the surface, but the slipping plane is only about 18 ft. below the same surface, so that the upper part of the sheeting driven to hold back the earth was always under a much greater pressure than the lower and the up-hill side under a greater pressure than the down-hill side. In making the excavation, sheeting was first driven for a 24-ft. depth and after this depth had been removed, the hole was carried down in 10-ft. steps to the solid rock. Owing to the slipping earth the upper section was displaced as much as 2 ft. and, in at least one of the pits, excavation outside of the sheeting had to be continually carried on so as to reduce the pressure. Fortunately the ground below the slipping plane was a solid blue and yellow clay, which stood up well in excavation. In order to avoid timbering against the excessive slipping which would have been caused by water collecting in the pits further up-hill, the lowest pier was started first so that when the next higher one was built there would be a solid concrete pier for the sliding earth to back against. When all the conveyor piers were finished, work was started on the highest one of the head-house piers and continued progressively down-hill, the excavation of No. 2 being used to refill the pit around the finished No. 1.

All concrete was mixed dry at the bottom of the slope and hoisted on tracks by steam or electric power to the point where needed, there to be mixed with water and deposited.

The work was finished in June, 1907, and the plant, which was put into immediate operation, has met with thorough success, for no sign of slipping whatever has been found in the piers, although the surrounding earth is in a state of decided unrest. The design and contract were carried out by the Reinforced Concrete Construction Co., of Cleveland, O., with Mr. E. F. Gosselin, of Troy, N. Y., as superintendent in immediate and responsible charge of the work. We are indebted to Mr. Gosselin for the drawings and information contained in this article.

THE ASPHALT PAVEMENTS OF KANSAS CITY were described in the last annual convention of the American Society of Municipal Improvements by Mr. E. A. Harper, City Engineer, as undergoing a process of scientific evolution. First, reasons for the indifferent success of the street department in this field were sought, pavements laid 15 to 20 years ago having been found to give better results than those put down within the last five years and long guarantees by the paving companies resulting in no addition to the life of the product. Investigation showed that the deficiencies of the contractors' work arose not from deliberate intent or carelessness, but from crudity of method and lack of modern scientific facilities. The chemical processes in use were evolved by a practical foreman possessing neither the skill nor the means for laboratory tests. It followed that not only were the usual difficulties of cracking, creeping and softening of the city's pavements insurmountable and unremedied, but the very foundation of success was uncertain inasmuch as the materials delivered were not checked for agreement with specifications. A testing equipment was therefore installed by the department, whose immediate utility may be judged from the fact that the first tank of flux examined was found to contain 5% water and 18% of matter volatilizing at a heat of 325° F. maintained for seven hours, a condition in itself accounting for all cracks. As the office became familiar with its work it was extended beyond the mere compulsion of close adherence to former specifications, these were improved and amplified and a rigid system of field inspection was instituted. The flux now obtained contains no water, does not flash below 300° F. and must not volatilize more than 5% when heated for seven hours at 325° F. The asphaltic cement "must not flash below 350° F., must contain no water, must not show more than 4% loss in weight on being heated seven hours at 325° F., and must not show a loss of more than 8½% in weight on being heated for seven hours at 400° F. It must not contain more than 4½% of carbonaceous matter insoluble in carbon bisulphide, and must not show more than 15% of fixed carbon, and must not contain more than 3% of paraffin scale." In the matter of foundation material, the public and the city fathers were first educated to repudiate the lobby interested in the old system of supply, and now only good Portland cement foundations are used. Proper sand grading and careful rolling with a ten-ton roller, both lengthwise and crosswise, not less than five hours for every thousand square yards, complete a pavement from which an honest life and service can be expected.

A LARGE ELECTRIC FURNACE FOR THE MANUfacture of ferro-alloys is being constructed at Heroult, Cal. The general design is the same as that of a small experimental furnace there, which under Professor Lyon of Stanford University gave excellent results.

THE PARIS METROPOLITAN rapid transit line, it is reported, is making trials of elevators and moving stairs at some of its stations.

PLANIMETER MEASUREMENTS OF AREAS ON MAPS.

By JOHN C. HOYT,* Assoc. M. Am. Soc. C. E.

Accompanying most planimeters are tables giving either (1) the proper settings of the arm for maps of various scales so that the planimeter readings will give the area directly, or, (2) the settings so that the readings will give square inches and coefficients for reducing these readings to square miles.

In measuring drainage areas, however, it has been found to be more satisfactory to calibrate the planimeter, with the arm at any setting, directly from the map on which the area is to be measured than to use those tables. This method is applicable to maps constructed either on the Mercator or on the polyconic projection. By it considerable time is saved in making the measurement and greater accuracy is also obtainable, as errors due to shrinkage or stretch of paper and those due to the planimeter itself, are eliminated.

The calibration is readily made by determining the number of revolutions the planimeter makes in going round a quadrangle of equal extent in latitude and longitude and determining the value per revolution from the area of this quadrangle, as given in standard tables similar to the accompanying (which is published in the Smithsonian Geographical Tables), which value is applied to the planimeter reading on the area to be measured.

In the calibration a quadrangle should be chosen, the middle parallel of which passes approximately through the center of gravity of the area. This is necessary in order to equalize the variation in area due to differences in latitude. In case the area extends over several degrees of latitude, it may be necessary to divide it into two or more parts and calibrate the planimeter for each part.

In running out an area it is necessary to measure only the portions which do not occupy full quadrangles as the area for full quadrangles can be taken direct from the tables.

In using the planimeter, take an initial reading of the dial at any setting, not attempting to set it at zero. Move the pointer around the area in a clockwise direction and take the final reading. Change the position of the planimeter wheel on the paper, take another initial reading and move the pointer around the area in a counter-clockwise direction, and take a final reading. The difference between the initial and final readings in the two runs should check very closely and their mean will be the mean reading for the area. The double tracing of the area in this manner gives a check on the reading.

In some cases it is convenient to calibrate the planimeter, using the area of a state or county instead of the area of a quadrilateral. Standard areas of various states are given in Bulletin 302, U. S. Geological Survey, and areas of counties can be obtained from Rand and McNally Atlas Maps.

Unfortunately, in measuring drainage areas in many sections of the country, maps of sufficient detail are not available for determining accurately the boundaries of the areas. In general, importance can be given to maps of various sources as follows:

(1) Results of special detail surveys.
(2) Topographic sheets, U. S. Geological Survey.
(3) United States Land Office maps.
(4) United States Post Route maps.
(5) Rand and McNally Atlas maps.
(6) Miscellaneous State and county maps.

*Assistant Chief Hydrographer, U. S. Geological Survey, Washington, D. C.

AREAS OF QUADRILATERALS OF EARTH'S SURFACE OF 30′ EXTENT IN LATITUDE AND LONGITUDE.
(From Smithsonian Geographical Tables.)

Middle latitude of quadrilateral	Area in square miles.	Middle latitude of quadrilateral	Area in square miles.	Middle latitude of quadrilateral	Area in square miles.
° ′		° ′		° ′	
0 00	1,188.10	11 00	1,166.84	22 00	1,103.68
0 15	1,188.08	11 15	1,165.86	22 15	1,101.77
0 30	1,188.05	11 30	1,164.86	22 30	1,099.84
0 45	1,188.00	11 45	1,163.85	22 45	1,097.88
1 00	1,187.92	12 00	1,162.81	23 00	1,095.91
1 15	1,187.82	12 15	1,161.75	23 15	1,093.92
1 30	1,187.70	12 30	1,160.67	23 30	1,091.90
1 45	1,187.56	12 45	1,159.56	23 45	1,089.87
2 00	1,187.39	13 00	1,158.44	24 00	1,087.81
2 15	1,187.20	13 15	1,157.29	24 15	1,085.74
2 30	1,186.99	13 30	1,156.12	24 30	1,083.64
2 45	1,186.76	13 45	1,154.93	24 45	1,081.52
3 00	1,186.51	14 00	1,153.72	25 00	1,079.39
3 15	1,186.24	14 15	1,152.48	25 15	1,077.23
3 30	1,185.95	14 30	1,151.23	25 30	1,075.05
3 45	1,185.62	14 45	1,149.95	25 45	1,072.85
4 00	1,185.28	15 00	1,148.65	26 00	1,070.64
4 15	1,184.92	15 15	1,147.33	26 15	1,068.40
4 30	1,184.53	15 30	1,145.99	26 30	1,066.14
4 45	1,184.13	15 45	1,144.63	26 45	1,063.86
5 00	1,183.70	16 00	1,143.25	27 00	1,061.56
5 15	1,183.24	16 15	1,141.84	27 15	1,059.24
5 30	1,182.77	16 30	1,140.41	27 30	1,056.90
5 45	1,182.28	16 45	1,138.96	27 45	1,054.54
6 00	1,181.76	17 00	1,137.50	28 00	1,052.16
6 15	1,181.22	17 15	1,136.00	28 15	1,049.76
6 30	1,180.66	17 30	1,134.49	28 30	1,047.34
6 45	1,180.08	17 45	1,132.96	28 45	1,044.90
7 00	1,179.48	18 00	1,131.41	29 00	1,042.44
7 15	1,178.86	18 15	1,129.83	29 15	1,039.97
7 30	1,178.20	18 30	1,128.24	29 30	1,037.47
7 45	1,177.53	18 45	1,126.62	29 45	1,034.95
8 00	1,176.84	19 00	1,124.98	30 00	1,032.41
8 15	1,176.13	19 15	1,123.32	30 15	1,029.85
8 30	1,175.39	19 30	1,121.64	30 30	1,027.27
8 45	1,174.63	19 45	1,119.93	30 45	1,024.68
9 00	1,173.86	20 00	1,118.21	31 00	1,022.06
9 15	1,173.06	20 15	1,116.47	31 15	1,019.43
9 30	1,172.23	20 30	1,114.71	31 30	1,016.77
9 45	1,171.39	20 45	1,112.92	31 45	1,014.10
10 00	1,170.52	21 00	1,111.11	32 00	1,011.40
10 15	1,169.63	21 15	1,109.28	32 15	1,008.69
10 30	1,168.73	21 30	1,107.44	32 30	1,005.96
10 45	1,167.80	21 45	1,105.57	32 45	1,003.20
23 00	1,000.43	44 00	890.25	55 00	687.70
23 15	997.64	44 15	856.67	55 15	683.44
23 30	994.83	44 30	853.07	55 30	679.17
23 45	992.00	44 45	849.46	55 45	674.89
24 00	989.16	45 00	845.82	56 00	670.60
24 15	986.29	45 15	842.18	56 15	666.29
24 30	983.41	45 30	838.51	56 30	661.97
24 45	980.50	45 45	834.83	56 45	657.64
25 00	977.58	46 00	831.13	57 00	653.29
25 15	974.64	46 15	827.42	57 15	648.93
25 30	971.68	46 30	823.68	57 30	644.55
25 45	968.70	46 45	819.94	57 45	640.17
26 00	965.70	47 00	816.18	58 00	635.77
26 15	962.68	47 15	812.40	58 15	631.36
26 30	959.65	47 30	808.60	58 30	626.93
26 45	956.60	47 45	804.79	58 45	622.49
27 00	953.52	48 00	800.97	59 00	618.05
27 15	950.43	48 15	797.13	59 15	613.59
27 30	947.32	48 30	793.27	59 30	609.11
27 45	944.21	48 45	789.39	59 45	604.62
28 00	941.05	49 00	785.50	60 00	600.13
28 15	937.88	49 15	781.60	60 15	595.62
28 30	934.71	49 30	777.68	60 30	591.09
28 45	931.51	49 45	773.74	60 45	586.56
29 00	928.29	50 00	769.79	61 00	582.01
29 15	925.06	50 15	765.83	61 15	577.45
29 30	921.80	50 30	761.85	61 30	572.88
29 45	918.53	50 45	757.85	61 45	568.30
30 00	915.25	51 00	753.84	62 00	563.71
30 15	911.94	51 15	749.82	62 15	559.11
30 30	908.61	51 30	745.78	62 30	554.49
30 45	905.27	51 45	741.72	62 45	549.86
31 00	901.91	52 00	737.65	63 00	545.23
31 15	898.54	52 15	733.57	63 15	540.58
31 30	895.14	52 30	729.47	63 30	535.92
31 45	891.73	52 45	725.36	63 45	531.25
32 00	888.30	53 00	721.23	64 00	526.57
32 15	884.85	53 15	717.08	64 15	521.88
32 30	881.39	53 30	712.93	64 30	517.17
32 45	877.91	53 45	708.76	64 45	512.46
33 00	874.41	54 00	704.57	65 00	507.74
33 15	870.90	54 15	700.38	65 15	503.01
33 30	867.37	54 30	696.16	65 30	498.26
33 45	863.82	54 45	691.94	65 45	493.51
44 00	488.75	74 00	331.62	82 00	157.37
44 15	483.97	74 15	326.58	82 15	152.37
44 30	479.19	74 30	321.53	82 30	147.36
44 45	474.40	74 45	316.48	82 45	142.35
45 00	469.60	75 00	311.42	83 00	137.34
45 15	464.78	75 15	306.36	83 15	132.33
45 30	459.96	75 30	301.28	83 30	127.31
45 45	455.13	75 45	296.21	83 45	122.29
46 00	450.29	76 00	291.12	84 00	117.27
46 15	445.45	76 15	286.04	84 15	112.24
46 30	440.59	76 30	280.94	84 30	107.22
46 45	435.72	76 45	275.84	84 45	102.18
47 00	430.84	77 00	270.73	85 00	97.15
47 15	425.96	77 15	265.62	85 15	92.12
47 30	421.06	77 30	260.50	85 30	87.08
47 45	416.16	77 45	255.38	85 45	82.05
48 00	411.25	78 00	250.25	86 00	77.01
48 15	406.34	78 15	245.12	86 15	71.98
48 30	401.41	78 30	239.98	86 30	66.94
48 45	396.47	78 45	234.83	86 45	61.90
49 00	391.53	79 00	229.68	87 00	56.86
49 15	386.58	79 15	224.53	87 15	51.82
49 30	381.62	79 30	219.37	87 30	46.78
49 45	376.65	79 45	214.21	87 45	41.74
50 00	371.68	80 00	209.05	88 00	36.69
50 15	366.70	80 15	203.88	88 15	31.65
50 30	361.71	80 30	198.70	88 30	26.61
50 45	356.71	80 45	193.52	88 45	21.56
51 00	351.71	81 00	188.34	89 00	16.52
51 15	346.69	81 15	183.15	89 15	11.48
51 30	341.68	81 30	177.96	89 30	6.43
51 45	336.65	81 45	172.77	89 45	1.39

BY A SPECIAL BOND ELECTION the city and County of San Francisco, on May 11, voted to issue bonds to the amount of $18,200,000 for various municipal improvements, for the most part made necessary by the earthquake and fire of 1906. These improvements comprise an auxiliary water system for fire protection, a sewer system, school houses and lands, hospitals, a hall of justice and county jail and a garbage disposal plant. Some of these were approved in a bond election of 1903, but owing to certain financial difficulties, the entire issue was not sold. The main new item of the recently proposed issue is $5,200,000 for an auxiliary water-works system for fire protection, the necessity for which was so thoroughly impressed on the citizens in the 1906 catastrophe. The $1,000,000 garbage disposal plant is also original in the new project. The new bonds are to be arranged so that the main expense on the citizens will not come for some years, when the larger part of the private rebuilding has been completed.

AN ORE-DEVELOPMENT of great importance to Goldfield was made during the week ending May 16, when a rich deposit was found on the 600-ft. level of the Mohawk mine; justifying the hopes of the richest gold camp in the world, that its ore continues with depth. From the upper part of this, the Hayes-Monette chute, a single carload was shipped for a return of $584,000.

OPERATING RESULTS OF THE MUNICIPAL ASPHALT REPAIR PLANT, BOROUGH OF BROOKLYN, NEW YORK CITY.

A plant for preparing asphalt for repairing pavements in Brooklyn, N. Y., was put in use on June 13, 1907. We give below the substance of a report on the construction and operating costs of this plant to Dec. 31, 1907, recently made by Mr. John C. Sheridan, Chief of the Bureau of Highways, Borough of Brooklyn. The report was addressed to Mr. Thos. R. Farrell, Superintendent of Highways, and has been supplied to the journal by Mr. Bird S. Coler, President of the Borough.

The asphalt plant is located on the South St. Basin of the Gowanus Canal. It has a nominal capacity of 270 cu. ft. of wearing surface and 100 cu. ft. of binder per hour. It was erected under contract by the Warren Asphalt Paving Co., and was described by the company in its bid of December, 1906, as embodying the results of its experience in building 42 plants during the previous six years.

The buildings housing the plant are of steel frame, covered with galvanized corrugated iron, with its second and third floors of reinforced concrete.

The asphalt plant includes three Warren rotary dryers, hot storage bins, mixing boxes, melting tanks, a barrel elevator and various accessories, besides a 60-HP. boiler, a 56-HP. and a 9-HP. engine. A summary of the cost of constructing the asphalt plant, and the repair equipment follows, all but the first item being outside the Warren contract:

Contract	$22,485
Engine and boiler foundation, piles, etc.	510
Office and sheds	712
Fire extinguisher	150
Oil tank	395
Extra parts, machinery	412
Office furniture and equipment	174
Electrical work, wiring, lights, annunciators	59
Four asphalt rollers	6,156
Twelve asphalt trucks	4,920
Tools and gang equipment	2,000
Miscellaneous	337
	$38,280

The fixed charges, to Dec. 31, 1907, were as follows:

Interest on payments on above at 5%	$897
and depreciation on plant at 10% for 6½ months, on $37,892	2,052
Rent of plant grounds, $1,440 for 7 months	840
	$3,789

During the 6½ months the plant was operated it produced 6,951 boxes of wearing surface of 9 cu. ft. each at the plant, which consolidated in transportation to about 8.75 cu. yds. each, making a total of 60,821 cu. ft. on the street. The output of binder was 1,524 boxes or (since this did not consolidate appreciably in transportation), 13,716 cu. ft.

The cost of supervision, labor and materials required to produce the finished products just quoted were as follows:

Superintendent Asphalt Repairs		$1,363
Plant labor (including foremen)		12,188
Street labor (including foremen)		19,970
Trucking, team and driver, at $6 per day		7,915
Trucking, wood (68 cords)		771
Coal for wood (68 cords)		149
Dumping privilege		166
Oil		92
Water		150
Portland cement		35
Canvas covers		63
Miscellaneous supplies		262
Coal for rollers, 47.6 tons, at $5.50		1,254
Coal for plant, 315 tons, at $3.98		206
Repairs to tools		777
Repairs to plant		893
Fluxing, 6,820 lbs. or 12,102.5 gals., at 7⅞ cts.		
Asphalt, 40 tons, at $24.77 per ton		
295 tons, at 24.80 per ton		8,307
Stone dust, 206.2 tons, at $3.50 per ton		764
Binder stone, 586.4 cu. yds., at $1.45 cu. yd.		850
Asphalt sand,* 2,871 cu. yds., at 75 cts. cu. yd. (Less credit on 100 yds., at 75 cts. of grit to Wallabout.)		2,078
		$58,248
Fixed charges		3,790
		$62,037

*Sand measured in scow (as paid for) allows for waste, in yard, tailings and loss of weight on moisture. The actual quantity of heated dry sand as weighed in on mixing platform was 2,136 cu. yds.—weights of stone, asphalt flux and dust as weighed in.

The unit costs of this work, per cubic foot, were as follows, the wearing surface costs being per box of 8.75 cu. ft. on the street and the binder costs per box of 9 cu. ft.:

	Wearing surface. Per cu. ft.	Binder. Per cu. ft.
Materials	$0.1894	$0.1004
Supervision:		
Fixed charges, etc.	.1223	.1190
Labor and trucking	.5402	.5252
Totals	$0.8519	$0.7446

In still more detail the cost figures were:

ANALYSIS OF COSTS.

General costs.	Wearing surface.	Binder.
Superintendence	$0.0184	$0.0179
Plant labor	0.1645	0.1598
Street labor	0.2695	0.2618
Trucking	0.1067	0.1037
Wood-fire wagon fuel	0.0103	0.0101
Coal-plant	0.0169	0.0164
Coal-rollers	0.0034	0.0034
Dump privilege	0.0020	0.0020
Rent	0.0113	0.0110
Interest	0.0120	0.0117
Depreciation	0.0277	0.0269
Repairs to tools	0.0027	0.0027
Repairs to plant	0.0103	0.0102
Miscellaneous supplies	0.0068	0.0066
Total	$0.6625	$0.6442
Flux	$0.0139	$0.0037
Asphalt	0.1287	0.0347
Sand	0.0342	.....
Dust	0.0126	.....
Stone	.....	0.620
Total	$0.1894	$0.1004
Grand total	$0.8519	$0.7446

Notes.—The charge for trucking, $7,915, is total truck time at $6 per day, and includes all delays at plant and on street and also trucking old asphalt and debris to dump. The average haul was 4.14 miles from plant.

Observation on 35 loads for rate of travel for loaded trucks, 72 cu. ft. wearing surface on load, gave 2.15 miles per hour.

Have had free dump on a considerable quantity of old asphalt. Cannot give quantity. The total number of working days was 134 out of 202.

The wages paid (8-hr. day) were: Plant foremen, $6 per day; foremen, $4 per day; rakers, $2.50 per day; tampers, $2.50 per day; smoothers, $2 per day; laborers, $2 per day; trucks, $6 per day.

A COAL MINE EXPLOSION originating from the carelessness of a miner, killed seven men in the Mount Lookout Colliery at Wyoming, Pa. A gas feeder had been left burning all night, setting fire to the timbers and coal. The fire was discovered early during the morning shift and a force of picked fire-bosses worked all day in the effort to subdue it. A slight explosion occurred when they began work. In the evening, most of the mine workers being fortunately already at or near the bottom of the shaft preparatory to quitting for the day, a more serious explosion occurred with the result noted above.

A TORNADO IN EASTERN NEBRASKA on May 12 killed 12 persons, seriously injured about 20 others, and damaged residences, business houses and public buildings in the towns of Belleview, Louisville and Ritchfield to such an extent as to cause the greatest storm loss ever experienced in this district. The college buildings alone at Belleview are injured in an amount approximating $50,000.

Storm casualties and damage are also reported from Louisiana and Texas, May 13. The village of Gilliam, La., was largely demolished, eleven inhabitants being killed. Houses at Leonard and Crandall, Tex., were wrecked.

A STRIKE ON THE CLEVELAND, OHIO, STREET railway system was started on May 16, when about 1,350 conductors and motormen of the Municipal Traction Co. walked out. The strike has been attended with considerable violence, as the striking employees have attempted to stop the running of cars, and in spite of the assistance of the police, several of the working employees have been injured and some property destroyed. The strike is an outcome of the recent transferral of management of the street car lines of the city, noted in our issue of May 7. The original holders of one of the lines had an agreement with the employees to increase their pay 2 cts. an hour but the new company refused to recognize the agreement, offering instead an increase of 1 ct. an hour. This increase was not accepted and the strike followed.

TESTS OF A PRODUCER-GAS PUMPING PLANT of The Westford Water Co., of Westford, Mass., have been reported by Mr. E. M. Blake, of Blake & Symonds, Consulting Civil Engineers, 8 Beacon St., Boston, Mass. This water company supplies water for domestic consumption and fire protection and their plant comprises 8.16 miles of mains, 42 fire hydrants, two steel standpipes for high and low pressure services and an $80,000 suction gas-producer pumping plant. The water supply is drawn from several 2½-in. tubular wells which tap a coarse, water-bearing, gravel stratum. The pumping plant has one four-stroke cycle, horizontal, single-cylinder, throttle-governed, heavy-duty, gas engine (Olds) with a normal capacity of 50 B.HP. There is an air compressor, for starting, which is driven by a small independent gasoline engine. The station has a 60-HP. suction gas producer (Pintsch system) for anthracite pea coal. The pump is an 8 × 12-in. heavy type, vertical, triplex (standard Smith-Vaile) having a calculated capacity of 310 U. S. gals. per min. against a maximum pressure of 200 lbs. per sq. in. With the standpipe full the pressure on the high-pressure service line at the station is 158 lbs. gage, and on the low-pressure line is 92 lbs. Two tests have been made on this plant, one of 6 hrs. 12 mins. duration in February, 1908, the other a 24-hr. continuous run in March. The following data are taken from the test reports:

Short Test.	
Period covered	6 h. 12 mins.
Total lbs. water discharged (allowing 1% slip)	852,219.08
Equivalent total height, water lifted	404.60 ft.
Ft.-lbs. work done	344,807,841.3
HP., pump end	28.08
HP.-hrs., pump end	174,096
Total lbs. coal consumed	271.75
Av. lbs. coal per hr.	43.8
Lbs. coal per HP.-hr., pump end	1.56
Av. gals. per min.	275
Duty per 100 lbs. coal	126,884,210
Av. I.HP., engine	34.3
I.HP.-hrs., engine	212.66
Lbs. coal per I.HP.-hr., engine	1.27
Pump efficiency	81.8%
Composition of Coal (by weight).	
Moisture	3.1%
Volatile	9.1%
Fixed carbon	75.8%
Ash	12.0%
	100.0%
Composition of Producer Gas (by volume).	
Hydrogen (H_2)	9.20%
Light Hydrocarbons (CH_4)	2.10%
Carbon Monoxide (CO)	19.13%
Carbon Dioxide (CO_2)	5.80%
Oxygen (O_2)	1.10%
Nitrogen (N)	62.67%
	100.00%

24-hr. Test:	
Period covered	24 hours
Total lbs. water discharged (allowing 1% slip)	3,334,786.7
Equivalent total lift	416.21 ft.
HP., pump end	29.21
HP.-hrs., pump end	701.04
Total lbs. coal fired	960.0
Av. lbs. coal fired per hour	40.00
Lbs. coal per HP.-hr., pump end	1.37
Pump efficiency taken from previous test	81.8%
I.HP., engine (on this basis)	35.71
I.HP.-hrs., engine	857.04
Lbs. coal per I.HP.-hr., engine	1.12
Duty per 100 lbs. coal fired	144,580,370
Lbs. ashes removed	97
Duty per 100 lbs. combustible	100,831,080
Cost of coal, delivered at station per 100 lbs.	$0.26
Total cost coal fired	2.50
Cost of cylinder and lubricating oil (3 gals.)	1.05
Cost of gasoline for starting engine and blowing to producer (½ pt. at 16 cts. per gal.)	0.01
Engineer's charge (at $3.23 per 10 hrs.)	7.75
Cost of pumping water for scrubbers and engine (18,000 gals.)	0.50
Total station expense chargeable to run	11.81
Cost of pumping 1,000 gals. under conditions of test	0.03
Cost of raising 1,000,000 gals. 1 ft. high	0.072

DECREASED RAILWAY ACCIDENTS reflect the decreased pressure of traffic, according to the accident figures for the last quarter of 1907 just issued by the Interstate Commerce Commission. The casualties in the quarter were 20,458 (1,092 killed and 19,366 injured), a decrease of 338 in killed and 148 in injured as compared with the same period of 1906. The quarter shows 2,004 collisions and 1,870 derailments, of which 337 and 202, respectively, affected passenger trains. About $3,000,000 damage was done by these accidents, an average of about $750 for each. Curiously enough, the collisions decreased in number by 132, but there were 131 more derailments, so that the total is only 1 less than in the last quarter of 1906. This record includes accidents on interstate electric lines with those on steam lines, and it is noteworthy that the worst derailment in the quarter was that of an electric car running alone.

DEATHS AND DEATH RATES from typhoid fever and diarrheal diseases in Chicago for the first four months of each nine-year period before and since the opening of the Drainage Canal are given in the weekly bulletin of the Department of Health (W. A. Evans, M. D., Commissioner) for May 9, 1908. For the nine years 1891-99 there were 2,004 deaths from typhoid fever, giving an average rate for the period of 54.2 per 100,000 population; whereas for the nine years 1900-08 there were only 1,007 deaths, which, taking into account the increase in population, gave an average of only 17.6 per 100,000 and a decrease in the rate of 67.5%. For the first nine-year period given above, there were 3,781 deaths from diarrheal diseases, giving an average of 95.7 per 100,000; and for the second nine-year period there were 3,622 deaths, which gave an average of 62.3 per 100,000 and a decrease of 34.9%.

A ROLLING-MILL ENGINE installed a few months ago at the Donora (Pa.) plant of the Carnegie Steel Co. is rated at 5,000 HP., but can develop 10,000 HP. The engine operates a three-high 30-in. billet mill, and the high reserve power is rendered necessary from the fact that five passes may occur simultaneously, thus throwing a heavy overload upon the engine. The engine is of the Corliss tandem-compound condensing type, with cylinders 46 × 60 ins. and 80 × 60 ins. The pistons are conical, and sliding shoe supports are provided for the tail rod and the intermediate piston rod. The connecting rod is 15 ft. long, and is attached to a crank-pin 18 × 18 ins. for a 30-in. shaft. The flywheel is composed of ten sections, each consisting of one spoke and a segment of the rim. They are connected at the rim by 8 × 8-in. links with T-heads shrunk into recesses. At the hub, the spokes are bolted between two heavy disks 8½ ft. diameter. The wheel is 24 ft. diameter and weighs 100 tons. The engine takes steam at 150 lbs. pressure, and runs at 80 r. p. m. It was built by the Wisconsin Engine Co., of Corliss, Wis.

A NATIONAL COMMISSION for the Conservation of Natural Resources is provided for by a bill introduced by Senator Newlands, of Nevada, on May 19. The bill authorizes the President to appoint a commission of 50 to investigate all questions relative to the conservation, use and control of the natural resources of the United States.

TESTS OF BRIDGE MEMBERS and other elements of steel construction are to be conducted on a large scale at the instigation of the "Verein Deutscher Brücken & Eisenbaufabriken." This society has appropriated money for such tests. The work is to be done in cooperation with the interested government authorities.

PERSONALS.

Mr. L. G. Murphy, Assistant Engineer of Construction and Maintenance of Way on the Boston & Albany Ry., has been appointed Assistant to E. E. Stone, Chief Engineer of that road.

Brigadier-General Alexander MacKenzie, Chief of Engineers, U. S. A., will retire from active service May 25, at the age of 64 years.

Mr. E. B. Ashby, Engineer of Maintenance of Way, Lehigh Valley Railroad, has been appointed Chief Engineer, vice Mr. W. G. Berg, deceased. His offices will be at 143 Liberty St., New York City.

Second Lieutenant Carlos J. Stolbrand, Corps of Engineers, has been relieved from duty with the First Battalion of Engineers, Philippines Division, and is ordered to Washington Barracks, D. C., for duty.

Major B. B. Gordon, Chief Engineer of the Frisco lines in Louisiana and Texas, has resigned, and is succeeded by A. M. Kiser who was his chief assistant in building the Colorado Southern, New Orleans and Pacific R. R.

Mr. Joseph Lyons, a young electrical engineer, is in the Harlem Hospital of New York City, nearly blind from the action of fumes of hydrochloric acid to which he was exposed while working at the Standard Oil plant at Astoria, L. I. He may recover his sight after months of treatment.

Mr. Thomas F. Mullaney severs the business ties of more than 20 years in leaving the General Electric Co., from which he has resigned to become Chief Engineer of the Third Avenue Railroad of New York City. At a farewell dinner tendered him on the evening of May 6 by his old associates, he was presented with a handsome gold watch and chain.

Mr. W. D. Waltman, for the last three years Assistant Superintendent of Construction of the Culebra Di-

vision of the Panama Canal, has been appointed Superintendent of Construction at Porto Bello. He will here have charge of the quarrying, crushing and delivering into ocean barges of the stone required for concrete work on the Gatun Locks.

Prof. Ira O. Baker, M. Am. Soc. C. E., has obtained a year's leave of absence, beginning July 1, from the University of Illinois, with whose department of civil engineering he has been connected for 34 years. He will devote a part of the time to the revision of his work on "Masonry Construction." During his absence, Prof. J. P. Brooks will take charge of the executive duties of the department.

Mr. William J. Wilgus, M. Am. Soc. C. E., formerly Vice-President of the New York Central & Hudson River Railroad Co., announces the organization of the "Amsterdam Corporation, Engineers," under his presidency, with the specified purpose of acting in an initiatory as well as consulting capacity on special railroad problems, such as electrification of steam lines, subaqueous tunnels, passenger and freight terminals and analyses of operating contracts. Mr. Henry J. Pierce, President of the International Railway Co., of Buffalo, N. Y., will act as vice-president of the firm.

Mr. Asa E. Phillips, M. Am. Soc. C. E., former Assistant Engineer, Sewer Department, District of Columbia, has been temporarily appointed superintendent of the Department, to succeed Mr. David E. McComb, now Chief Engineer of the Paving and Sewer Department of Havana, Cuba. It is understood that on July 1 he will assume the position permanently. Mr. Phillips has been a member of the engineering staff which he now heads, for nearly 18 years. His principal work during this time has been the designing, construction and supervision of the Washington, D. C., sewage disposal system.

Obituary.

Benjamin Cutter Kingsbury, the discoverer of copper in Montana and the original owner of the famous Anaconda Mine, died May 7, at the age of 73 years. He had received a technical mining education, and was one of the pioneer operators in the Butte, Coeur d'Alene, Rossland and Republic Districts.

Arthur Koppel, the late President of the Arthur Koppel Co., whose death was briefly mentioned in the last issue of Engineering News, was the founder of the largest manufacturing firm of portable and industrial railways in the world. Born in Dresden, Germany, 57 years ago, he received no technical education, but his mind at an early age grasped the practical commercial possibilities of the field to which his life was afterward so successfully devoted. From a small beginning, thirty years ago, he evolved an establishment comprising six large manufacturing plants, at Koppel, Pa., Bochum, Germany, Fives-Lille, France, Budapest and Prague, Austria, and St. Petersburg, Russia, with offices in every commercial center in the world. He was a strong advocate of narrow-gage railways. The 24-in. gage Otavi Ry. in German Southwest Africa, 361 miles in length, built by his firm, is the longest line of its type in the world. The town of Koppel near Pittsburg, Pa., laid out by the firm as its American factory site, is one of the most advantageously located industrial towns in the country. The total working force of the international company includes 6,000 workmen and an engineering and commercial staff to the number of 1,500.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 19-22. Annual convention at Chicago. Secy., W. W. Freeman, 29 West 39th St., New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 26-28. Annual meeting at Chicago. Secy., W. H. Merrill, Jr., 382 Ohio St., Chicago.

WESTERN RAILWAY CLUB.
May 29. Annual meeting, postponed from May 19. Auditorium Hotel, Chicago, Ill. Secy. Joseph W. Taylor, 390 Old Colony Building, Chicago.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 9-11. Annual convention at Toronto, Ont. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 22-24. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 23-26. Annual convention at Denver, Colo. Secy., C. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 23-26. Annual convention at Detroit, Mich. Secy., C. W. Rice, 29 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-26. Annual meeting at Detroit, Mich. (In connection with convention of American Society of Mechanical Engineers.) Secy., A. L. Williston, Pratt Institute, Brooklyn, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 23-27. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 29-July 2. Annual convention at Atlantic City, N. J. Secy., Ralph W. Pope, 33 West 39th St., N. Y.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 24-25. Summer meeting at Niagara Falls, N. Y. Secy., W. M. Mackay, P. O. Box 1818, New York City.

THE CANADIAN RAILWAY CLUB.—The society has elected the following officers for the ensuing year: President, L. R. Johnson, M. Can. Soc. C. E., Assistant Superintendent of Motive Power of the Canadian Pacific Ry.; Secretary, James Powell; Treasurer, S. S. Underwood.

BROOKLYN ENGINEERS' CLUB.—Through the courtesy of the Edison Portland Cement Co. the club was enabled to inspect the cement plant of the company at New Village, N. J., on May 16. A special train of four cars left the Hoboken station of the D., L. & W. R. R. at about 11 a. m., reaching the plant at 2.30 p. m., luncheon being served on the train. About two hours were spent in going over the plant from quarry to sacking house and the party returned on their own train, reaching the city at 7 p. m.

THE CONCRETE INSTITUTE.—A new society has been formed under this name with headquarters at No. 1 Waterloo Place, London, England. Its objects are: "To advance the knowledge of concrete and reinforced concrete, and direct attention to the uses to which these materials can be best applied. To afford the means of communication between persons engaged in the design, supervision, and execution of works in which concrete and reinforced concrete are employed; to arrange periodical meetings for the purpose of discussing practical and scientific subjects bearing upon the application of concrete and reinforced concrete, and to conduct such investigations and to issue such publications as may be deemed desirable." The officers are: President, The Right Hon. The Earl of Plymouth, C. B., etc., late First Commissioner of Works, 1902-5; Hon. Secretary, A. E. Collins, M. Inst. C. E., City Engineer, Norwich; Hon. Treasurer, E. P. Wells.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—At the next semi-annual meeting of the society, to be held in Detroit, Mich., June 23-26, discussions on machinery for the hoisting and conveying of materials are allotted large space on the program. Among other subjects are: "The By-Product Coke Oven," by W. H. Blauvelt, Consulting Engineer, The Semet-Solvay Co., Syracuse, N. Y.; "A Simple Method of Cleaning Gas Conduits," by W. D. Mount, General Superintendent, The Mathieson Alkali Works, Saltville, Va.; "A Journal Friction Measuring Machine," by Henry Hess, President, Hess-Bright Manufacturing Co.; "A Rational Method of Checking Conical Pistons for Stress," by Prof. G. H. Shephard, Professor of Experimental Engineering and Machine Design, College of Applied Science, Syracuse University, N. Y.; "Thermal Properties of Superheated Steam," by Prof. R. C. H. Heck, Professor of Experimental Engineering, Lehigh University; and "Horsepower, Friction Losses and Efficiencies of Gas and Oil Engines," by Prof. Lionel S. Marks, Assistant Professor of Mechanical Engineering, Harvard University. Prof. John A. Brashear, of Allegheny, Pa., will deliver a lecture on "Contribution of Photography to Our Knowledge of Stellar Evolutions." A visit to the University of Michigan at Ann Arbor is among the excursions planned. The sessions will be so arranged that the meeting of the Society of Automobile Engineers and of the Society for the Promotion of Engineering Education may also be attended by members interested.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—At the annual meeting of the institute, held May 19, at the Engineers' Building, 29 West 39th St., New York City, the following officers were elected for the coming year: President, L. A. Ferguson, Second Vice-President of the Chicago Edison Co., Chicago, Ill.; Vice-Presidents, C. C. Chesney, Chief Engineer of the Stanley-G. I. Electric Co., Pittsfield, Mass., Calvert Townley, First Vice-President of the Consolidated Railway Co., New Haven, Conn., Bancroft G. Gherardi; American Telephone & Telegraph Co., New York City; Managers, D. B. Rushmore, General Electric Co., Schenectady, N. Y.; H. E. Clifford, Massachusetts Institute of Technology; C. W. Stone, General Electric Co., Schenectady, N. Y., W. G. Carleton, Superintendent of the Port Morris Power Station, New York City; Secretary, R. W. Pope, New York City; Treasurer, G. A. Hamilton, New York City.

At this meeting two papers on the lightning protection of transmission systems were presented. The first of these, by Mr. J. F. Vaughn, of the Stone & Webster Corporation, Boston, Mass., related the tests made of all the common devices available on the Taylor's Falls transmission system of the Minneapolis General Electric Co. This paper was composed of such a mass of details that only scant report could be made here of the subject matter. A few summaries, however, are interesting to quote:

Storms did not follow well defined paths nor were the effects confined to particular parts of the line.

Stresses did not occur at definite points in the line.

The principal disturbances were due to immediate static charges on the line in the immediate vicinity of storms. These charges are of great intensity and concentration, frequently "spilling over" a number of insulators with-out traveling along the line more than a few hundred feet. Such disturbances may occur anywhere on the line but with a preference for exposed heights and to a less degree to wet lowlands.

Overhead grounded wires are of decided value in shielding the line from induced static charges and in preventing insulator breakdowns.

A grounded conductor running down the pole is of decided value in preventing splintering of the pole.

The paper of Mr. N. J. Neall, Boston, Mass., "Studies in Lightning Performance, Seasos of 1907," largely corroborative of Mr. Vaughn's interpretation of data and showed also the results obtained on the Fe[illegible] of the Presumpscot Electric Co., near Portland, Me.

WASHINGTON SOCIETY OF ENGINEERS.—A dinner was given by the society in cooperation with the Washington members of the American Society of Civil Engineers on the evening of May 12 to the Presidents of the National Engineering Societies who were in Washington to attend the conference on the Conservation of Natural Resources. The President of the Washington society, Mr. Arthur Powell Davis, Chief Engineer of the U. S. Reclamation Service, acted as toastmaster. The following is an excerpt from Mr. Davis' opening remarks:

It is significant and extremely fortunate that a great convention like that now in Washington, called by the President, to confer regarding the best methods of conserving the natural resources of our common country, is attended by the official representatives of the great engineering societies of the country. The conservation of natural resources means their economic use, and so far as possible their perpetuation, and within the meaning and purpose of the convention called, it also means their preservation from reduction to perpetual monopoly, and for the benefit of all the people. That this is one great purpose of this movement, no one can doubt who has read recent presidential messages. It is inevitable that the greatest, wisest and best men will differ as to details and specific measures to secure the desired result with reference to a question relatively new to human experience. But no one can doubt that such a conference as the one now in Washington of representative leaders will be productive of great good.

Mr. John Hays Hammond, President of the American Institute of Mining Engineers, said:

It has unfortunately become our custom to speak of the natural resources of our country as illimitable, and consequently to regard the discussion of the conservation of these resources as academic, or at the best, as scientific speculation. All efforts heretofore of a few enthusiastic theorists—as they were considered—have availed naught to disturb this imperturbable complacency and optimism. To-day, however, at the eleventh hour, thanks to the persistency of these same far-sighted, public spirited, and eminently practical men, we realize for the first time the gravity of the situation. We see, at last, that this is not a subject affecting future generations only, but that it is one of vital and immediate concern to ourselves and to our children. We see, too, that it is not a question confined to particular localities, nor to special classes in the community, but that it is one of transcendent interest to every inhabitant of this land. Furthermore, we see that the greatness of our nation itself, based as it is upon its industrial, commercial, and financial supremacy, depends absolutely upon the conservation of its natural resources, and we recognize, therefore, the fact that the spirit of patriotism, as well as that of enlightened self-interest, demands our hearty cooperation in this great work.

As engineers we apprehend the inter-dependence of the several problems submitted for the consideration of this important and representative congress, and we should be insistent upon the necessity of a comprehensive and coordinated scheme—not desultory plans—embracing: First, the preservation of the forests, the "sine qua non" of this problem; Second, the conservation of the flood waters of our rivers in their upper regions, together with the control of these waters in the lower levels of the river systems, that is to say, storage and drainage; Third, the reclamation of our swamp lands; Fourth, the improvement of our inland waterways, so as to render them available for navigation.

The engineering profession will necessarily be given an important part in this great work, and our cooperation must not be merely a sentimental one, but must consist of active professional assistance to the extent, if necessary, of making great personal sacrifice in the discharge of our civic duty.

Dr. Chas. B. Dudley, President of the American Society for Testing Materials, said:

A single phase of the subject that will occupy our attention for the next few days, has caused me some thought. Every one at all conversant with the matter acknowledges the frightful waste of the nation's resources which has characterized the past, and if we are candid and fair, it seems to me that this waste cannot all be attributed to greed. A moment's attention to the conditions that have prevailed will make the matter clear.

Those who have been harvesting the marvelous lumber crop of our virgin forests, with such unparalleled shortsightedness, those who have been taking only what may be called the cream from the coal mines, for example, have done so not purely for profit, but because only in this way could they get a product that they could sell in competition with others. The market, that is the consumers, would have only the best, and the producers naturally have taken from forest or mine and offered only the best.

If this diagnosis is correct, it would seem, and this is the thought that I want to leave with you, that at least one of the remedies for the appalling waste of the past, must start with the consumers. Engineers and those who are making specifications for materials, must be less rigid in their demands, or must so modify their constructions or methods, that something less than the very best will accomplish the purpose. In short, there must be a paying market for that enormous portion of the nation's natural resources which is now going to waste with such startling rapidity.

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